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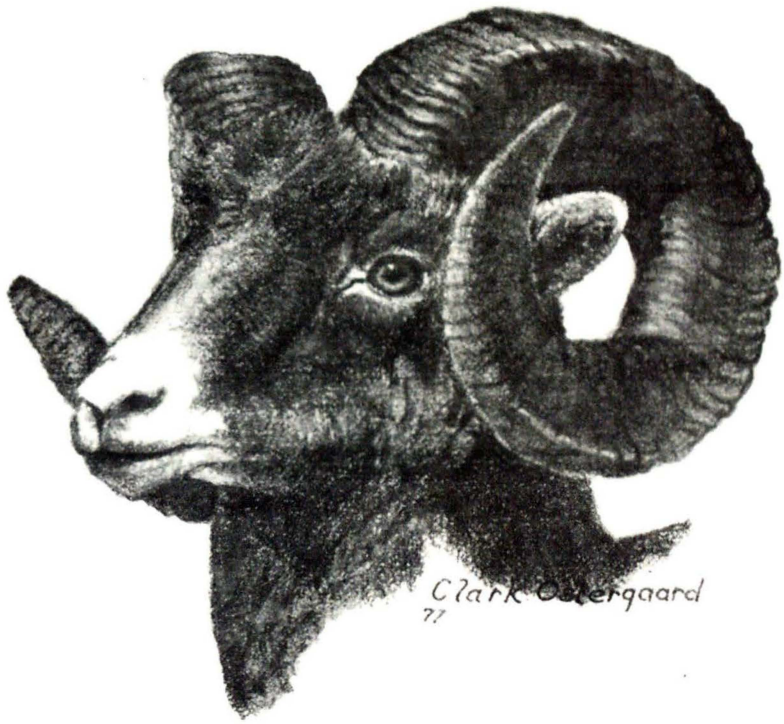
Evaluation of Environmental Suitability of a Portion of the Wasatch Front for BIGHORN SHEEP

by Ron Sikes 1977



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Region 4, Wasatch National Forest
Logan · Ogden Ranger Districts

EVALUATION OF ENVIRONMENTAL SUITABILITY OF A PORTION OF THE WASATCH FRONT FOR BIGHORN SHEEP

Region 4

WASATCH NATIONAL FOREST

Logan and Ogden Ranger Districts

Prepared By

RON SIKES

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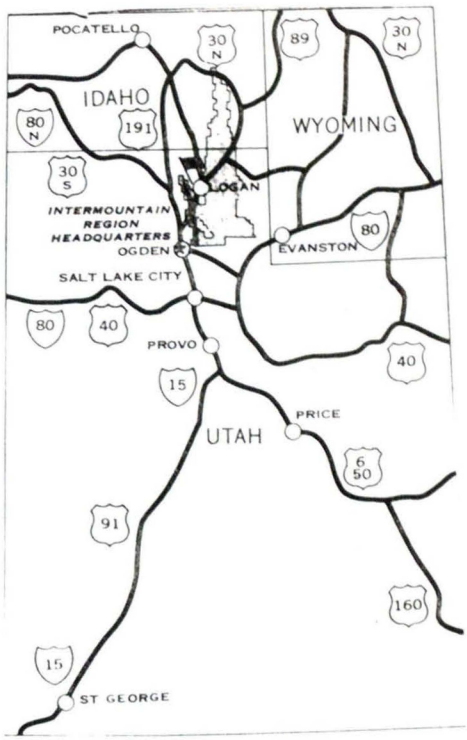

study area

I. INTRODUCTION

This report is a biological appraisal of the reintroduction possibilities of Rocky Mountain Bighorn Sheep (Ovis canadensis canadensis) into the Wasatch Front Range from Weber Canyon near Ogden, Utah, north to Deweyville, Utah.

The objectives of this study are to provide land managers with information concerning:

1. Evaluation of the land's suitability for bighorn sheep.

2. Problems that may arise as a result of bighorn sheep reintroduction.

3. Information of the bighorn sheep escaped from the state enclosure.

4. Recommendations.

The direction and portions of the general outline for this report are based on the Rocky Mountain Bighorn Sheep Habitat Study (Proposed Re-Introduction) prepared by Jim Kimbal, Wildlife Biologist, U.S.F.S.; W. F. Savage, Range Conservationist, U.S.F.S.; and Dick Worthen, Game Biologist, Utah Division of Wildlife Resources, January 31, 1972.

Assistance From Others

Jack Rensel, John Kimbal and Dwight Bunnell, Utah Division of Wildlife Resources, Northern Region, made available their files on the Bighorn Sheep Transplant Project. Also, they provided information concerning habitat suitability and answered many questions.

Mont Lewis, Department of Range Management, U.S.F.S., provided plant identification for unknowns collected in the field.

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Glenna Wright and Paul Shields, U.S.F.S., Division of Wildlife Management, made the department's library accessible and assisted in location of literature sources.

Stan Miller, Range Conservationist, Logan District, U.S.F.S., provided information on livestock allotment, recreational use, and bighorn sightings on the Wellsville Range.

Margaret McGregor, District Clerk, U.S.F.S., Ogden Ranger District, assisted with phone contacts, film processing, location of materials, and answered many questions.

Kathy Geilmann, Clerk Stenographer, U.S.F.S., Ogden Ranger District, assisted in locating materials, typing and editing the report.

Janet Newbold, Typist and Clerk, U.S.F.S., Ogden Ranger District, prepared letters of communication and assisted with typing and editing the report.

Debbie Taylor, Typist and Clerk, U.S.F.S., Ogden Ranger District, typed final copy.

Mac Thomson, Recreation Forester, U.S.F.S., Ogden Ranger District, provided statistics on visitor day use in the units of the study area.

Dee Ritchie, Ranger, U.S.F.S., Ogden Ranger District, shared his knowledge and experience with bighorn sheep in Wyoming. This information was used as an aid in predicting bighorn sheep range boundaries.

Clint Groll, Range Conservationist, U.S.F.S., Ogden Ranger District, shared office space, insured transportation, provided instructions on range analysis and preparation of stereo models for mapping, and answered many questions.

Preston Jackson, Forestry Technician, U.S.F.S., Ogden Ranger District, helped with transportation problems, provided infor-

mation on bighorn sheep sightings, directions to specific areas in the units, and contacts for permission to trespass.

Jim Kimbal, Wildlife Biologist, Wasatch National Forest, prepared an outline for execution of this project and provided maps, overlays, and reports of the Rocky Mountain Bighorn Habitat Study (1972) and the Rocky Mountain Goat Habitat Study (1969).

Preston Affleck, Clyde Huss, and Lynn Wiese, Department of Geometronics, U.S.F.S., provided instructions for preparation of stereo models and the job order for the vegetation map.

Dr. Warren C. Foote, Department of Animal Sciences, Utah State University, provided assistance in gaining information on disease transmission in bighorn sheep.

Earl Olsen, Department of Environmental Geology, provided information for a geological description for the study area.

II. BIGHORN SHEEP CHARACTERISTICS AND REQUIREMENTS, A LITERATURE REVIEW

A. Characteristics

1. Behavior*

There are two social classes in mountain sheep society - one contains the most dominant rams, with the lesser rams, ewes, and juveniles forming the other. Subordinate rams and estrous ewes are behaviorally the same in the presence of dominant rams. Behavior of non-estrous ewes is similar to juveniles.

Except during the rut, mature rams mostly remain separate from the female and juvenile bands. By late summer, lambs form juvenile bands although they remain near adult ewes.

Juvenile mountain sheep learn home ranges from the mature members that they choose to follow. Thus, wild sheep have traditional home ranges. Juveniles are tolerated by all older members of sheep society and are not forced from groups to wander alone.

* Information of behavior in mountain sheep society was taken from the Mountain Sheep by Valerious Geist, 1971, world renown authority on evolution and behavior of North American Mountain Sheep.

Mountain Sheep behavior works against dispersal of the young into unoccupied habitats to form new populations. Only when catastrophic events operate to create habitat next to or overlapping traditional ranges does a sheep population realize expansion of its habitat.

Smith (1954) found the average bighorn sheep band of Idaho to number 8 animals. Rams were found alone in significantly greater numbers than ewes or juveniles. During the rut, rams seek out estrous ewes, moving from band to band. Geist (1971) observed that rams often visit rutting grounds distant from their winter range and are known to leave one mountain range, cross through large blocks of non-typical habitat, and move onto another. Some rams were observed to move about 15 miles.

Bighorn rams are known to join domestic sheep. Smith (1954) reported an incident of a young bighorn ram remaining for ten days with a band of 60 domestic sheep. Moser (1962) related an incident in Colorado of four lambs born of bighorn ram-domestic ewe matings. In the files of Utah Division of Wildlife Resources is an account of a lamb born in the spring of 1960 in the Coalville area from a bighorn-domestic ewe union.

2. Migrations

Generally Rocky Mountain Bighorn move into the higher elevations during summer. Winter requires movement onto wind swept ridges and southern exposures where food sources are not deeply covered with snow. Before settlement of the west some bighorn populations moved down onto the plains and rolling hills during winter snows (Buechner, 1960; Smith, 1954; Moser, 1962; Honess and Frost, 1942). Now practically all Rocky Mountain Bighorn sheep populations are limited to mountain winter ranges (Buechner, 1960).

Typically pregnant ewes move into cliff type terrain to give birth where they remain during the lambing period, about four weeks (Geist, 1971). After this period the ewe-lamb groups move to summer ranges at higher elevations. Here they join ewes without lambs and yearlings. Usually ram groups precede the ewe-yearlings bands to the summer ranges. Some individual and small groups have been observed to not migrate, rather remaining in one local area year round (Smith, 1954).

Transplanted mountain sheep in the study area of the Wasatch would be expected to occupy the higher ele-

vations throughout the year but moving down during periods of deep snow. Areas on north facing and east facing slopes that have continuous deep snow coverage will not be used during winter, however. Spring green up would draw sheep onto the sunnier open slopes at the lower elevations.

Progression of plant phenology combined with drying of the west and south exposures would encourage sheep movement to the higher elevations to coincide with the start of green growth. Summer should find them foraging predominantly in subalpine* forb and open conifer types. Use is also expected on the highest and more rugged ridges that support mountain sagebrush types during this period. Late summer and fall would be spent mostly on the north and east slopes. Foraging is expected primarily in the open conifer and moist forb types. Here plants should be more succulent due to higher moisture content and a later start in their development. Especially during dry years, when snow banks disappear early, bighorn can be expected to locate near perennial springs and ponds. Irvine (1969) found that 82 percent of the observations of desert Bighorn sheep of southeastern Utah were within one mile of water.

* Vegetation types are discussed in Section IV, D.

Snowfall with over 6 inches accumulations is expected to move mountain sheep to lower elevations. This is suggested in the study by Honess and Frost, 1942, where they noted that generally bighorn did not paw through snow deeper than six inches. Smith (1954) reported mountain sheep pawing through 18 inches of snow cover to forage. However, he indicated that fresh snows of a few inches would move sheep to lower elevations. After snow storms some mountain sheep return to wind swept ridges to forage (Buechner, 1960; Smith, ibid.; Moser, 1962; Honess and Frost, ibid.; Geist, 1971). Sheep occupying the lower elevations are expected to use the sparse sagebrush, sagebrush, sagebrush-grasstypes, and openings in the browse type. Here except during periods of deep snow, grasses and forbs are expected to provide the main forage. Rock outcrops and cliff areas supporting mountain mahogany would provide resting and hiding places.

Storms bringing deep snows may temporarily move sheep onto agricultural areas. A band of the escaped bighorn were observed in the hayfield of a Pleasant View, Utah, resident (Wade, Nov., 1976, personal communication). However, information from the literature review indicates that bighorn normally winter on the broken terrain of mountain slopes and wind swept ridges (Honess and Frost, 1942; Smith, 1954; McCulloch and Schneegas, 1966).

3. Reproduction and Recruitment

A summary of reproductive events are provided in Table 1. It does not represent a complete survey of the literature.

TABLE 1

Event	Time Span	Source
Rut	Mid Nov. thru Mid Dec.	Honess and Frost, 1942(Wyo); Green, 1949 (Banff Nat. Park, Canada)
	Mid Nov. thru last Dec.	Smith, 1954 (Idaho)
Gestation	175 days	Geist, 1971 (Banff Nat. Park, Canada)
	180 days	Smith, ibid.
Lambing	Late May thru early July	Honess and Frost, Ibid.
	Mid May thru early June	Smith, ibid.
	Late May to early June	Green, ibid.

Geist, (1971) characterized two types of mountain sheep populations: (1) those that live near the limits of the carrying capacity of the range, showing lowered reproduction, high mortality of lambs, long-lived adults, and small body and horn development; (2) those living in a new habitat after being introduced by man or by natural means. The latter type exhibit high reproduction, high recruitment, large size, early maturation, and short-lived adults. Most

American mountain sheep populations are of the low reproduction long-lived adult type. The escaped Canadian bighorn of the study area on the Wasatch may be this type population (Kimball, personal communication, Nov. 1976). The escaped bighorn that were brought to Utah from Wyoming showed high reproduction, 7 lambs from 9 mature ewes for a ratio of 78 lambs/100 mature ewes for 1966.

One lamb born per ewe is the normal. Geist (ibid.) theorized that single births allow for relative insurance of survival of the lamb to yearling age through larger body size and no competition for the ewe's milk supply.

Reproduction rates have been measured from observed lamb-ewe ratios. The low of 17 lambs per 100 ewes was noted by Murie, 1944, in Mt. McKinley National Park. The highest ratio given in the literature was 100 lambs per 100 ewes (Woodgert, 1964, Wild Horse Island, Montana).

Recruitment measured by observed yearling-ewe ratios showed from 38 (Smith, 1954, and Honess and Frost, 1942) to 65 yearlings per 100 ewes (Buechner, 1960).

Bighorn sheep life expectancy is from eight to ten years. (Murie ibid. and Geist ibid.)

Under favorable conditions some bighorn populations have shown annual increases of 25 to 40 percent (Buechner, ibid.).

4. Mortality

Winter stress - As previously mentioned researchers have found that most American mountain sheep populations suffer very high mortality in the lamb age group; and low mortality in the yearling to 10 year old age group. Since Bighorn sheep live on limited winter ranges on mountain slopes, severe winters result in lowered survival success of lambs born the following spring (Smith, 1954). Honess and Frost (1942) theorized that low phosphors levels in winter forage on some Wyoming ranges resulted in low lamb survival. Geist (1971) emphasized that low lamb survival resulted from winter stress on the ewe during the time of fetal development. The effect of winter stress may affect life expectancy through the first year of life.

Predation - Predation has not been shown to be a major cause of decline in bighorn sheep populations (Honess and Frost, ibid.; Smith, ibid.; Buechner, 1960; Moser, 1962; Geist, ibid.).

Disease - Early decline in bighorn is suspected to have occurred from mite scabies contracted from domestic stock (Buechner, ibid.). Indians living in Wyoming claimed to never have seen this disease in mountain sheep until the arrival of domestic flocks (Honess and Frost, ibid.).

The lungworm disease - Pneumonia complex is believed to operate in conjunction with high density concentrations of sheep on dwindling forage supplies. (Buechner, ibid. and Moser, ibid.).

Mountain sheep are susceptible to a host of infectious disease carried by domestic livestock (Foote, personal communication, Nov., 1976).

Illegal hunting - Smith (1954) indicated that illegal hunting was important to the decline of some accessible herds in Idaho. Honess and Frost (1942) reported that during years of heavy snowfall, late season hunters killed illegally 2 to 6 sheep per year. They considered it a significant loss to the Jackson Hole herd.

Accidents - Smith noted several accidental deaths to mountain sheep during his two-year study. A lamb was found trapped on a ledge in a weakened condition and appeared to be slowly dying from exposure, hunger, and stress. One mature ram was found dead from a fall. Several sheep carcasses were found in the rubble of rockslides and the debris of avalanches. Geist (1971) noted that broken legs were not uncommon among mountain sheep. Moser (1962) reported two bighorn carcasses where the head including the mouth were filled with porcupine quills.

B. Habitat Requirements

General

Smith (ibid.) listed the following habitat requirements for bighorn sheep:

1. The habitat be located in a wilderness or other undeveloped area.

2. Adequate forage, no serious competition from other big game or livestock.

3. Presence of open bunchgrass associations.

4. Ruggedness of topography.

Geist (1971) contrasted the moose which depends on successional stages of vegetation to the mountain sheep that exist on stable grassland communities.

Modern day sheep habitat is "patchy" and not continuous. Geist (ibid.)

The ruminant digestive system of the mountain sheep with its symbiotic protozoan and bacterial components allows the animal to exist on "hard, abrasive, dry forage of poor quality." Geist (ibid.)

Present day Rocky Mountain Bighorn populations exist largely on alpine and subalpine vegetation types in summer (Buechner, 1960). Grasses, sedges, and forbs predominate in importance. (Table 2 below). While browse is used lightly in summer its importance magnifies as grasses and forbs pass maturity and dry in late summer. After much of the low herbage is covered by winter snows, the importance of browse further increases (Smith, 1954).

Table 2 Stomach Analysis of 8 Wyoming bighorn sheep as follows: 2 in March, 1 in April, 1 in July, 1 in August, 1 in fall, 1 in November (Honess & Frost, 1942).

Percent	Plant Group
50.8	Grasses and sedges
29.6	Forbs
19.4	Browse

Smith (1954) reported an average for yearlong observations of forage utilization by bighorn sheep as: 70% grasses and grass-like plants and forbs; 27% browse; and 3% moss and lichens. During summer grasses and forbs made up 86% of the observations.

Morgan (1969) reported sheep forage utilization on Idaho's Morgan Creek range during the winter of 1968-69 as: 74.65% grasses and grass-like plants, 6.20% forbs, 19.13% browse.

Minerals

Soils of high mountain ranges are sometimes lacking in certain minerals. As a result, animals that forage on these ranges must supplement this deficiency by seeking out and eating soils containing the needed minerals. As noted, low

phosphorus levels were suspect of low reproduction in Wyoming (Honess & Frost, 1942). However, supplemental salting on bighorn ranges has not proved to increase reproduction or lamb survival (Moser, 1962). Forage on the study area is believed to provide all necessary minerals for big game.

Water

Geist (1971) and Smith (1954) observed that bighorn sheep eat snow to meet their water requirements. Green (1949) did not consider open water on feeding areas a requirement for bighorn in Banff National Park. He observed that they would travel from high ranges down to valleys for water.

In the study area on the Wasatch Front, open water is expected to be necessary for mountain sheep survival. During dry summers all snow banks can be expected to disappear. Open water occurs in several perennial springs and ponds scattered along portions of the Front. A sighting of an ewe and lamb apparently coming to water at Wellsville Cone spring was reported during the summer of 1976.

Effect of Fire

Buechner (1960), Moser (1962) and Geist (1971) mention expansion of bighorn habitat from fires. Reduction of competition

from woody plants and release of nutrients as a result of fire creates or improves grass and forb stands. Also fire can create corridors through non-typical brush and timber stands. Movement through these openings into new habitats is then possible.

The average burn along the Wasatch Front covers approximately one acre.

C. Competition from domestic livestock

Depletion of bighorn range has been discussed at length in the literature. Grazing of cattle, domestic sheep and horses have attributed in great part to declines and present low numbers on some bighorn ranges. See Honess & Frost (1942), Smith (1954), Buechner (1960), Moser (1962), Capp (1968), Morgan (1969), and Irvine (1969). Irving (ibid.) observed that when cattle were brought into an area occupied by desert bighorn that the sheep moved out. Nelson (1975) found that cattle produced the same reaction in elk.

D. Bighorn Sheep - their effect on the environment

Overutilization of Forage

Buechner (1960) wrote that local areas of the Tarryall-Kenosha Range of Colorado showed localized signs of vegeta-

tive destruction and soil erosion. Disease mortality related to low nutrition and high infection pressure can result in large die offs.

Erosion Sites

Geist (1971) described these sites as bedding and social interaction areas. They are generally located on grass slopes and ridge tops. These sites have some "visible effects on the mountain" inhabited by sheep.

Competition with Other Wildlife

That bighorn sheep suffer from competition with other big game has been stressed in literature, not the reverse. Partly due to their relatively slower reproduction rate bighorn cannot effectively compete with deer and elk. (Capp, 1968). Competition between deer and bighorn has been measured in situations where deer were considered overabundant Smith (1954), Buechner (ibid.), Honess & Frost, (1942) and Morgan, (1969).

Elk diets contain high proportions of grass (Murie, 1951). Honess and Frost reported 70 to 80 percent grass in elk stomach analysis. Bighorn decline as a result of high competition from elk (Buechner, 1960).

It should be noted here that few elk are known to range in the study area. (John Kimbal, personal communication, 1976).

McCullough and Schneegas (1966) found "strong separation" between deer and Sierra Nevada bighorn during winter observations. These mountain sheep occupied the cliffs and "less precipitous (terrain) with loose, continuously eroding, decomposed granitic soil broken by granitic outcrops and strewn with large boulders." Deer occupied the denser bitterbrush stands and some north facing slopes opposite bighorn sheep winter range.

Kimbal (personal communication, Nov., 1976) observed that the bighorn sheep confined in the paddock near Brigham City apparently ignored summac in preference for grasses. Summac (Rhus Glabra) is highly utilized by deer in the study area.

Bighorn - Domestic Sheep Interactions

As discussed, bighorn rams are known to enter bands of domestic sheep. Lambs have been born from their cross breeding. John Fricke of the Utah DWR reported that a 2.5 year old ram had appeared in a band of domestic sheep near Mantua, Utah, in October, 1970 (DWR files). The literature review did not

show that these bighorn ram-domestic ewe unions were frequent enough to be of economic significance. See appendix A for location of known domestic sheep bands along the west boundary of the study area in December 1976.

Water Quality

Erosion sites and overutilization have been discussed. That these factors were large enough in size to affect the water quality in terms of sediment and/or bacteria was not stated (see Geist, 1971 and Buechner, 1960).

Written communications received from Townsley (November 1976), Yellowstone National Park and Anderson (December 1976), Banff Park, Canada, did not mention any water quality problems related to bighorn sheep. As noted from the literature, bighorn habitat is generally scattered and populations are relatively small. It is doubtful that under such circumstances effects to water quality would be significant.

Disease Transmission

If prior to transplanting, bighorn sheep are properly quarantined, vaccinated and treated for parasites as required by law, then disease transmission to other big game and domestic animals is very unlikely (Call, personal communication, Nov., 1976).

E. Transplanting

Moser (1962) has discussed successful transplanting methods. In general, these are:

1. Provide an enclosure to hold sheep for treatment of stress and related disease outbreaks, protection from predation and harrassment.

2. Use initial stock for breeders, releasing offspring into selected areas.

3. Stock adequate numbers and correct sex ratios.

Kimbal et. al. (1972) mentioned two successful transplants in Colorado. They were composed as follows:

3 rams	1 ram
8 ewes (1-3/4 yrs. or older)	7 ewes (1-3/4 yrs. or older)
5 lambs	6 lambs

Records up to 1966 of transplants by the game department of New Mexico, Oregon, Washington, Colorado, Texas, Montana, and the province of British Columbia, have been reviewed by Geist (1971). Geist concluded that much former sheep habi-

tat is probably still suitable for sheep, that biologists can judge mountain sheep requirements, that failure of some transplants may be due to factors other than unsuitable habitat, and that most "introduced sheep remain limited in distribution and colonize no new habitat in addition to that about the release area." (Pages 120-121.)

F. Man - Bighorn Relationships

Background noise - This noise results from trains, factory whistles, blasting, heavy equipment, sonic booms, automobile traffic, etc. Except for automobile traffic, the effects of these noises on bighorn sheep are not known.

Bighorn sheep in some national parks tolerate traffic noise, apparently, as they often will take handouts from the roadside (Anderson, Dec., 1976 written communication; Thompson, personal communication, Nov., 1976; Riggs, telephone communication, Nov., 1976; Geist, 1970).

Human Disturbance

"Human disturbance can cause severe alterations to the behavior of a species with repercussions on the physiology, population dynamics, and ecology of the animals." (Geist, 1970, page 413). Geist (1971) noted that hunting of moun-

tain sheep on their winter ranges resulted in the animals desserting that part of the range. He concluded that if hunting could force sheep to abandon part of their range for a significant period, serious harm would result to the population.

Light and Weaver (1973) have researched the impact of recreational activities on bighorn sheep in the San Bernadino National Forest of California. Their findings are pertinent to the situation in the study area. Excerpts from their report are presented here:

> "Hiking Alone - A transient, occasional hiker has little lasting impact on bighorn. This report indicates less than 700 visitor days per year in any one area may be tolerated."
>
> Hiking in Groups - Bighorn tolerate some disturbances. Continued, frequent and especially erratic disturbances cause them to avoid concentration areas. Richard Weaver of the California Department of Fish and Game concludes that "groups of hikers often cause bighorn to avoid their habitat" and further states that, "roads and trails in prime bighorn habitat are bad news because their use will increase and bighorn habitat will be displaced, ... suggests that existing trails into bighorn

habitat have hiker limitations of no more than 10 per group per area and no more than 700 - visitor days per area, per year."

Horseback Riding - Horseback riding does not detrimentally affect bighorn (DBC 1972) .... Here again, man's activity when off the horse should be considered and groups of horsemen should be regulated in size and frequency as in hiking groups.

Motor Vehicles - Closed cars and trucks have little detrimental effect on bighorn (DBC, 1972). Motorbikes and snowmobiles on the other hand have caused bighorn to temporarily leave their sanctuaries. The motorbike with its noise and erratic, unhorselike appearance and movement appears to spook bighorn....

.... suggests restriction by numbers of motorbikes to existing designated roads in bighorn range.

Shooting - Discharge of firearms within the bighorn range needs to be controlled. Indescriminate shooting in the campground areas and from the trails at any convenient target is a continuous disturbance to bighorn... Bighorn have continuously been illegally taken within

the study area ... Discharge of firearms should be limited to taking of legal game in season.

The harvesting of deer and other game should continue to be lawfully harvested. Hunters and shooters, however, should be informed continuously of the bighorn values.

Aircraft - Bighorn in most cases run when pursued by helicopter (DBC, 1972). Infrequent surveys of bighorn by helicopter may be tolerated but if this becomes a sport, controls should be instituted to regulate this activity.

Campgrounds or Improved Wilderness - Camps - Located near natural water, mineral licks and important foraging areas have decreased in bighorn use as recreational use has increased (DBC, 1972).

Grazing - Grazing of cattle and domestic sheep should not be within two air miles of bighorn management unit perimeter.

Skiing - Ski lifts and tramways have little lasting effect on bighorn during the snow season; obviously, because bighorn are absent from what normally is their

summer range. The problem is the resultant summer recreational use, where the base of the lift is in relation to yearlong bighorn range and what impact construction may have on bighorn use of their range.

A different situation exists in some national parks. Bighorn in Yellowstone National Park are known to winter near residential areas (Townsley, written communication, Nov., 1976).

Geist (1970) observed that:

> "Bighorn sheep inhabiting Mount Norquay in Banff National Park are thriving despite the Trans-Canada Highway and a paved road up the mountain; despite a chair lift, a hotel, a ski lodge, a coffee shop, and heavy recreational use."

He concluded that if bighorn are given protection from hunting and poaching, they would not only tolerate humans but would benefit from the relationship.

Glacier National Park - From 1920 to 1937 bighorn sheep in the Many Glaciers area of the park were fed hay at a site on their wintering ground. The sheep are believed

to have become positively acclimated to humans as a result. Feeding by park visitors has probably reinforced this relation. Park Service notes (1937) on sheep behavior indicated that when people were near the mountain sheep showed concern but did not flee. (Riggs, Dec., 1976, telephone communication). Riggs observed human activity on a lambing ground in the same area. It was not apparent that sheep were avoiding the area or using it less. Some of the mountain sheep seemed to ignore humans. While ewes and juveniles are fed by park visitors along some roads and near campgrounds, rams were observed to remain more distant and were harder to approach.

It is concluded from the foregoing studies and observations that bighorn sheep will tolerate human presence if not threatened. However, human activities that condition mountain sheep with fear and flight can cause avoidance of critical habitat that receive high visitor use.

III. DISCUSSION OF BIGHORN SHEEP RANGE OF IDAHO, COLORADO, AND THE WASATCH RANGE OF UTAH

A. Colorado

In Colorado summer ranges occur mostly between 10,000 and 12,000 foot elevations. Here bighorn sheep utilize alpine meadows, cliff bases, open ridges, glacial cirques, avalanche and fire scars. In these areas they seek highly palatable sedges, grasses and forbs. Winter range in Colorado occurs between elevations of 4,000 and 7,000 feet in areas of less steep topography with patches of broken rocky terrain. Vegetation is typically open bunch grass mixed with spots of browse, particularly currant, wild rose and willow (Buechner 1960 and Moser, 1962).

B. Idaho

In Idaho mountain sheep summer at elevations usually above 8,000 feet in subalpine vegetation. This type occurs in the upper limits of the spruce fir zone between forest and barren peaks. Depending on the severity of the weather bighorns range from the higher ponderosa pine-lodgepole pine open conifer type down to rolling hills and steep canyon gorges of the Salmon River. At the lower elevations south faces provide bluebunch wheatgrass associations. Scattered

through the lower winter range are important browse species such as mountain mahogany and bitterbrush (Smith, 1954 and Buechner, ibid.).

Plants observed by Smith (1954) to be utilized by bighorn in Idaho are listed in Table I. Occurrence of these species or genus in the study area is indicated.

TABLE 3

Food Item (Idaho)	All Season Observations Combined	Occurrence in the Study Area on the Wasatch
Bluebunch wheatgrass	69	X
Idaho fescue	14	Limited Amounts
Arrowleaf balsamroot	10	X
Sedges	7	Limited Amounts
Rushes	4	No
Goats' beard	3	X
Horsetail	2	No
Hawkweed	2	X
Eriognum	2	X
Cheatgrass	2	X
Little ricegrass	2	X
Woodrush	1	No
Penstemon	1	X

Junegrass	1	X
Vetch	1	X
Thistle	1	X
Curleaf Mountain Mahogany	78	X
Big sagebrush	12	X
Rubber Rabbitbrush	7	X
Spiny grease bush	5	No
Suringa	4	No
Golden Currant	4	X
Bitterbrush	3*	Limited Amounts
Western Chokecherry	2	X
Rose	1	X
Willow	1	No
Labrador tea	1	No
Haplopappus	1	X
Small leaved huckleberry	1	No
Snowbush	1	X
Alder	1	No

Moss & Lichens

Moss and lichens	15	Limited Amounts

* "Bitterbrush was on less than half the winter ranges studied; consequently, this number does not reflect true importance of bitterbrush wherever it was present (Smith, 1954)."

C. Summary comparison between vegetation types on winter ranges of Idaho (Smith, ibid.) and those found on the study area of the Wasatch range.

Open conifer type in Idaho - Used by bighorn sheep during late summer and autumn on north facing slopes. Some winter use occurs in this type of southern exposures. Common plants are Douglas fir, Ponderosa pine, bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, suringa, golden currant and snowbrush. *Understory composition - 45% grass, 25% forbs, and 30% shrubs.

Open conifer type in Wasatch study area - This type mostly occurs on north facing slopes at the higher elevations (6,000 feet and above). Trees become very scattered on west and south exposures. Common plants are subalpine fir, Douglas fir, letterman's needlegrass, aster species, horsemint, Fremont's geranium, mountain lover, currant and snowberry. ** Composition of understory - 3% grass, 32% forbs, 65% shrubs.

Browse type in Idaho - Mountain sheep use is light on this relative to other types and unless it is adjacent to open grass or cliffs or contains numerous rock outcrops its use is limited. Greatest use to this area occurs when preferred

grasses and forbs are covered with snow. Common browse plants are mountain mahogany, snowberry and chokecherry. * Composition - grass 30%, forbs 30% and shrubs 40%.

Browse type in Wasatch study area - Found on most south and west faces and often extends from foot of mountain to near ridgeline. Common plants are Gambel oak, bigtooth maple, chokecherry, big sage, summac, arrowleaf balsamroot, western yarrow, herbaceous sagebrush, eriognum, bluebunch wheatgrass, Japanese brome and three awn. *** Understory composition - 9% grass, 19% forbs, 72% shrubs.

Cliff type in Idaho - Important to bighorn sheep for lambing. Also some use occurs for a few weeks in the spring and fall. Common plants are cheatgrass, arrowleaf balsamroot, mountain mahogany, spiny greasebrush, and Goodings gooseberry. * Understory composition - 30% grass and forbs and 20% shrubs.

Cliff type in Wasatch study area - Occurs along most of the Front's west face and on the south face in Weber and Ogden Canyons. Common plants are cheatgrass, Poa species, bluebunch wheatgrass, sandwort, tufted rockmat (Petrophytum) draba (Draba densifolia), mountain mahogany, holidiscus, and mountain sagebrush. ** Composition - 10% grass, 51% forbs, and 30% shrubs.

Open grass type in Idaho - This type made up 7% of the study area in Idaho but received 24% of the observed feeding by bighorn. Most of this type is on south exposures with relatively gentle slopes. Common plants are bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, western yarrow, lupine, Eriognum, spiny greasebrush, Gooding's gooseberry and elderberry. * Composition - 60% grass, 30% forbs, and 10% shrubs.

Sagebrush type in Wasatch study area - This type is comparable to the open grass type of Idaho. It occurs mainly on south and western exposures at elevations below 6,000 feet. Within this type are found almost pure stands of grass, particularly in areas that have been burned. Common plants are bluebunch wheatgrass, three-awn, Sandberg's bluegrass, western yarrow, arrowleaf balsamroot, herbaceous sagebrush, balsamroot (macrophylla), sunflower, big sagebrush, rubber rabbitbrush and black sagebrush. *** Composition 25% grass, 18% forbs, 57% shrubs.

* Smith, 1954.

** Kimball, Savage, and Worthen, 1972.

*** Utah Big Game Range Inventory, 1970-71.

IV. DESCRIPTION AND HISTORY OF THE STUDY AREA

A. Description

* Location and Boundaries

In northern Utah, natural forces have acted to create an abrupt high rugged mountain range. This range, known as the Wasatch Front, reaches from the Idaho border south to Nephi, Utah. The area considered in this report extends from South Maple Canyon, near Deweyville, Utah, on the northwest side of the Wellsville Range south to Weber Canyon just south of Ogden, Utah. The north end of the study area is bound by brush-covered spurs that descend to the Bear River Valley. On the west boundary begins the Great Basin containing the Great Salt Lake. More gentle slopes and sometimes dense mountain brush mark its perimeter on the east. The Weber River Canyon on the south end completes the boundary.

Relatively deep canyons disect the study area into four unequal units. They are named here in succession from north to south:

1. The Wellsville Unit - the portion from South Maple Canyon south to Box Elder Canyon.

* A location map will be found on page 2.

2. The Willard-Ben Lomond Peak Unit - the portion extending south from Box Elder Canyon to North Ogden Divide.

3. The Lewis Peak Unit - the portion south from North Ogden Divide to Ogden Canyon.

4. The Mount Ogden Unit - the portion extending south from Ogden Canyon to Weber Canyon.

Geology

The Wasatch fault is the most geologically distinctive feature. Benches formed by ancient Lake Bonneville are evident along the west face and extend up the canyons. Tintic quartzite is exposed on the west face while dolomites and Cambrian limestones are found in upper parts of the canyons and on ridgetops. The Ogden Canyon and the Ben Lomond thrust occurs on the north end of a Pre-Cambrian crystalline mass. This mass acts as a nucleus for compressed overlapping stratified layers and gives them their form (Eardly, 1944). Sedimentary rock range north from Ogden Canyon to and including the Wellsville Mountains. Pre-Cambrian rock is found along the west face particularly at Willard, Utah, and from Ogden Canyon south to Weber Canyon. Below 5,200 feet to about 4,600 feet are found the Bonneville silts and clays.

Several large landslides are found in the canyons and along the foot of the Wasatch Front. Several of these are over multimillion cubic yards of rock and earth. High country above 9,000 feet shows evidence of glaciation and perpetual snow and icefields that ended approximately 10,000 years ago. The remainder of the area is composed of slope wash and stream wash material (Earl Olsen, personal communication, Nov. 1976).

Physical Description

Wellsville Unit - Main drainages of the west are South Maple Canyon, Cold Water Canyon, Cottonwood Canyon, Precipice Canyon, and Flat Bottom Canyon. Eastern drainages are Willow, Deep, Shumway, and Brush Canyon. Major peaks are Mendon Peak, 8,766 feet, Scout Peak, 8,687 feet, Wellsville Cone, 9,356 feet, and Box Elder Peak, 9,372 feet.

Ben Lomond-Willard Peak Unit - There are three main drainages on the west, Perry Creek, Facer Creek, and Willard Creek. Cutler Basin on the east, situated between Willard and Ben Lomond Peak, drains via Cutler Creek into the North Fork of the Ogden River. Principal peaks are north to south, Grizzly, 8,272, Willard, 9,764, Ben Lomond, 9,712, and Chilly Peak, 8,459.

Lewis Peak Unit - Three main drainages on the west side are Cold Water Canyon, One Horse Canyon, and Jump Off Canyon. Lewis Peak, 8,031 feet, is the only named peak in this section.

Mount Ogden Unit - The western drainages are Taylor Canyon, Waterfall Canyon, Strong's Canyon, and Spring Creek Canyon. Cold Water Canyon drains north into the Ogden River. East drainages into Wheeler Creek are Chicken Spring and the Bear Hollow drainage. East drainages into the Weber River are Gordon Creek and Strawberry Creek. Principal peaks are Mount Ogden, 9,572 feet, Del Moisy, 9,369 feet, Strawberry Peak, 9,006 feet, and Middle Peak, 7,509 feet.

Soils

Location and a description of soil association are given here. Source, Utah Agricultural Experiment Station, Soils of Utah, Bull. 492.

1. Argic Cryoborolls-Phachic Cryoborolls-Cryic Paleborolls Association.

   This association is located mostly in the Wasatch Mountains and the Wasatch Plateau in northern and central Utah, in the Tushar and Cedar Mountains, and

the Sevier Plateau in Southern Utah. Elevations range from 8,000 to 12,000 feet, and slopes are rolling to very steep.

The soils in this association are moderately well to somewhat excessively drained. Permeability is slow to rapid. Runoff is medium to slow and sediment production is moderately low.

The principal native vegetation is aspen, spruce, fir and pine with associated grasses, forbs, and shrub.

These soils are used mainly as grazed woodland, water yielding areas, wildlife habitat, recreation and summer home sites, and for timber production.

22. Typic Argixerolls-Typic Haploxerolls Association

This association is widely distributed in the mountains of central and western Utah in the Great Basin Drainage. Slopes are steep to very steep. Elevations range from about 6,000 to 8,000 feet.

The soils in this association are moderately well to somewhat excessively drained. Permeability is moderately rapid to slow. Runoff is slow to rapid and sediment production is moderate.

The principal native vegetation is big sagebrush, snowberry, oakbrush, slender and bluebunch wheatgrass with other associated grasses, forbs, and shrubs.

The soils are used mainly for range, wildlife habitat, and water yielding areas.

23. Calcic Haploxerolls-Calcic Argixerolls Association

This association is located mainly on mountain slopes in northwestern Utah in Box Elder County. It is extensive in the Goose Creek, Grouse Creek, Hansel, and North Promontory Mountains, and in the Blue Springs Hills. Slopes are steep to very steep. Elevations range from 5,500 to 7,500 feet.

The principal native vegetation is bluebunch wheatgrass, big sagebrush, bitterbrush, and other associated grasses, forbs, and shrubs.

These soils are used mainly for range wildlife habitat and water yielding areas.

24. Lithic Haploxerolls-Typic Haploxerolls Association

This association is located in the Wasatch Mountains from northern Cache County southward to the

upper drainage of Weber River in Summit County. It is extensive along the steep mountainslopes east of Cache Valley extending southward to the south end of the Salt Lake Valley. This association also occurs in the Crawford Mountains in eastern Rich County. Slopes are steep or very steep. Elevations range from 5,800 to 8,000 feet.

The soils in this association are well to excessively drained. Permeability is moderate to moderately rapid. Runoff is medium to rapid and sediment production is moderate.

The principal native vegetation is big sagebrush, serviceberry, bitterbrush, mountain mahogany and some oakbrush, bluebunch wheatgrass, and other associated grasses, forbs, and shrubs.

These soils are used mainly for range, wildlife habitat, and water yielding areas.

25. Pachic Argixerolls-Typic Argixerolls-Calcic

This association occurs mainly in the Wasatch Mountains in northern Utah. It is most extensive in Cache, Rich, Weber, Morgan, Wasatch, and Summit

Counties. Small areas also occur in Box Elder and Utah Counties. Slopes are usually steep to very steep but gently rolling soils are included. Elevations range from about 5,200 to 8,000 feet.

The soils in this association are well to somewhat excessively drained. Permeability is slow to moderately rapid. Runoff is medium and sediment production is low.

The principal native vegetation is oakbrush, maple, snowberry, big sagebrush, bluebunch wheatgrass, bearded wheatgrass, and other associated grasses, forbs, and shrubs.

These soils are used mainly for range, wildlife habitat, water yielding areas, and recreation.

G. Dominantly dark-colored soils of lake terraces, fans, and valley bottoms that are usually dry during the summer, have an average annual precipitation of 35 to 55 centimeters (14 to 22 inches), a mean annual soil temperature of 8 degrees to 15 degrees C (47 degrees to 59 degrees F), and a mean summer soil temperature of more than 15 degrees C (to 59 degrees F).

This group of associations is shown in solid dark blue. There are 3 different associations numbered 26, 27, and 28 in this group.

The soils in these associations are located mainly on lake terraces and alluvial fans and valley bottoms along the western front of the Wasatch Mountains from the Idaho line south to Levan, and in Pavant and Tooele Valleys. Slopes are mainly smooth to gently undulating with some areas distinctly rolling and dissected with stream channels. They range from about 1 to 6 percent. Elevations range mainly from about 4,300 to 5,300 feet but some areas extend up to 6,000 feet.

The climate is dominantly dry subhumid and moist subhumid and characterized by warm dry summers and moderately cold moist winters. The mean annual soil temperature to 20 inches ranges from 8 degrees C to 15 degrees C (47 degrees to 59 degrees F). The freeze-free season is sufficiently long for the successful production of most farm crops when water is available for irrigation. Fruits are grown where there is good air drainage. The average annual precipitation ranges from 35 to 55 centimeters (14 to 22 inches), most of which comes from October through

May. Nonirrigated winter wheat is successfully grown on these soils where irrigation water is not available.

26. Calcic Argixerolls-Calcic Haploxerolls Association

This association is located mainly in the north central part of Utah. It occurs in Cache, Box Elder, Morgan, Weber, Davis, Salt Lake, Utah, Juab, and Millard Counties on lake terraces at elevations ranging from about 4,300 to 5,300 feet. Slopes are mainly smooth nearly level to gently sloping but some steep terrace escarpments are included.

The soils in this association are well and moderately well drained. Permeability is slow to rapid. Runoff is slow to rapid and sediment production is moderate to low.

The principal native vegetation is big sagebrush, wheatgrasses, and other associated grasses, forbs, and shrubs.

These soils are used mainly for cultivated land both irrigated and nonirrigated and urban development for homes and industries. Irrigated crops

include alfalfa, small grains, corn, and sugar beets. Where air drainage is good apricots, peaches, cherries, apples, and pears are also grown. The nonirrigated cropland is mainly in winter wheat.

27. Typic Calcixerolls-Calcic Argixerolls Association

This association is the most extensive of the soils in group G in solid dark blue on the map. It occurs on the high lake terraces, deltas, and old alluvial fans along the west base of the Wasatch and Pavant Mountains from Millard County to Cache County. Slopes are generally smooth and nearly level to gently sloping.

The soils in this association are well, moderately well and somewhat excessively drained. Permeability is rapid to moderately slow. Runoff is slow to rapid and sediment production is moderate to low.

The principal native vegetation is wheatgrasses, big sagebrush, and other associated grasses, forbs, and shrubs.

These soils are used mainly for cultivated cropland and for urban developments for homes and industries.

Irrigated crops are grown where water is available. These include alfalfa, small grain, corn, and sugar beets. Where air drainage is good, apricots, peaches, cherries, apples, and pears are grown. Nonirrigated cropland is mainly in winter wheat.

Climate

Most precipitation comes in the form of snow in the late fall, winter and early spring. Precipitation is often the result of middle latitude cyclonic storms from the northwest. Summer storms usually approach from the southwest. The east receives less drying from the sun due to shadows from the other mountain formations and less steep slopes. Above 8,000 feet precipitation ranges from 25 to 30 inches per year (USFS, 1965). North facing slopes, cirques, and east slopes at higher elevations have snow pack generally from November through May or longer. Snow banks persist on north slopes at the highest elevations through most of the summer.

Chaparral Vegetation Type

The broad vegetation type for the area as a whole is chaparral; a type where evergreen shrubs make up a major portion of the vegetation composition (Johnson, 1970).

Human Populations

Thirty-five towns and cities surround the study area. The 1970 census shows a collective total of 203,123. Ogden, Utah, is the largest with 69,478.

Human Activity in the Study Area

Note - Estimated numbers of visitor day use will be discussed in part IV, E.

Recreation - During the summer and fall months, particularly June through October, portions of the study area are highly popular with hikers, motorcyclists, horseback riders and hunters (fall). The Lewis Peak and the Willard - Ben Lomond Peaks Units have the easiest accessibility largely due to the number of well maintained trails. Inspiration Point in the Willard Peak area is accessible by car. Some target shooting is known to occur through most of the summer and fall in all units.

Aircraft - During September of 1975 an Airforce helicopter gunship was observed to make daily flights into the Ben Lomond-Willard Peaks area. Low circles were flown over Cutler Basin. During the summer of 1975 several flights were made by the USFS to the saddle just south of Ben Lomond Peak. Also during

this time period, private helicopter flights into the area were observed. During September of 1976 a private helicopter was seen to land in Inspiration Point after making a low flight through Willard Basin.

Four Wheel Drive Vehicles - Until the summer of 1975 Ben Lomond saddle was accessible via the Cutler Basin jeep trail. Until September of 1976, the saddle northeast from Willard Peak and overlooking Cutler Basin from the north, was accessible with four-wheel drive. Both of these jeep trails have been closed by the Forest Service. The crest of the Wellsville range is accessible by four wheel drive on both the north and south ends. The Mount Ogden crest is accessible by four wheel drive via the ski runs of Snow Basin. That portion of the jeep trail from Ogden Valley to the crest of the Lewis Peak Unit has been closed on the National Forest.

Recreation activity occurs along the lower benches of the study area throughout the year. Hunting, target shooting, and hiking activities are popular in the canyons during snow season. A full range of activities occur during the remainder of the year.

Harrassment from dogs - Mountain sheep moving down to the edge of the Wasatch Front during periods of deep snow would be subject to chase from dogs.

Recreational activities and dogs may exclude bighorn use along heavily populated parts of the lower winter range of the study area.

B. History of Bighorn Sheep in the Study Area

Past History

Journal of a Trapper by Osborne Russell recorded that bighorn sheep existed on portions of the study area in good numbers. On the 16th of December, Russell, accompanied by another trapper and his wife, left their camp in Cache Valley and headed for the Salt Lake Valley. They descended through Box Elder Canyon and made night camp near the mouth of the canyon. The morning of the 17th Russell went mountain sheep hunting and gave the following account:

> "After climbing about half a mile, I sat down on a rock to wait for daylight, and when it came, I discovered a band of about 100 rams within about 8 yards of me. I shot and killed one."

Russell and his party made winter camp near the mouth of Weber River. On the 2nd of February, he made a sheep hunt on the Mount Ogden range. Excerpts from his account of this hunt are quoted here:

"The 2nd day of February I took a trip up the mountain (Mount Ogden) to hunt sheep. I ascended a spur with my horse.... Where I found a level bench where the snow was off. I fastened my horse with a long cord and took along the side of the mountain among the broken craigs.. I had not rambled far when, just as the sun was sinking below the dark green waters of the Salt Lake, I discovered three rams about 300 feet perpendicular below me."

"I shot and killed one.... I was upward of 6,000 feet above the level of the lake...."

3rd of February: "About sun an hour high I commenced hunting among the rocks in search of sheep....

When crawling over some shelving cliffs, I discovered ten to twelve ewes feeding some distance below me. I shot and wounded one, reloaded my rifle and crept down to the place I last saw her, when I discovered two standing on the side of a precipice. I shot one dead and she fell over the cliff...."

Mr. Rulon White, a resident near Willard, Utah, is believed to be the last living person to have seen native bighorn sheep of this area. He related that during October, 1971, while looking for cattle on the upper north side of Willard

Canyon, he suddenly came upon a band of mountain sheep. The band, about 18 in number, took flight down some cliffs and disappeared. He was able to note a couple of mature rams mixed in with the ewes, lambs, and yearlings. He also related an incident of his neighbor, a Mr. Prior Facer, being chased out of a corral by a bighorn ram that had mixed with some milk cows.

About 25 years ago Mr. White found a bighorn ram skull in the mountains near his home. It is possibly the last remains of the native bighorn to this part of the Wasatch Front. He stated that the last he had heard about the native mountain sheep was that some were seen on the ledges somewhere along the Wasatch Front near Willard. Poachers were rumored to have shot some during the winter (personal communication, 24, Nov. 1976).

*Present History

Present history of mountain sheep on the study area concerns Utah's Division of Wildlife Resources attempts to re-establish bighorn on the Wasatch Front.

Initially a plan was made to build an enclosure in Big Canyon of the Wellsville Range on National Forest lands. In October of 1965 final decision on approval of the plan was held up for the completion of range analysis. This analysis

showed an estimated carrying capacity of about 21 to 31 bighorn sheep per year on the approximately 720-acre planned enclosure (Files, USFS, 1965). The Division of Wildlife Resources decided to use a contingency plan to build an enclosure on state land between Perry Canyon and Mathias Canyon, just south of Box Elder Canyon.

During the fall of 1965 the Division built an 80-acre paddock. The first mountain sheep (14 animals, 5 rams and 9 ewes) came from the Wind River Mountains of Wyoming and arrived on March 8, 1966.

In April of 1966 20 more bighorn sheep (6 rams, 14 ewes) were brought to the enclosure from Waterton National Park, Canada.

During the following winter, drifting snow from gale winds knocked out portions of the enclosure fence. Twenty-three bighorn escaped. Repairs were made under the most difficult winter conditions.

A larger paddock was constructed on the same site during the summer of 1967, enclosing approximately 1,000 acres with seven miles of fence.

On December 1969 a load of bighorn (12) arrived from Banff Park, Canada. A second shipment (14) came during January 1970.

Each winter drifting snow severely damaged enclosure fences. Observations showed that escaped sheep frequently returned to that area, some remaining in the enclosure voluntarily (Rensel, personal communication, Nov. 1976).

Winter storms of 1971-72 freed all the mountain sheep. From sighting records it appeared that most of the animals moved onto the Wellsville range, the Willard - Ben Lomond Peaks Unit, with some remaining in or near the enclosure.

A summary of numbers, sex and known mortality of the transplant are presented in Tables 4 and 5.

(See Tables 4 and 5 on next page.)

TABLE 4 Shows date of arrival, where from, number, sex and age group.

Mar. 66	Wyoming	9	F	mature
		1	M	mature
		4	M	lambs
	Total	14		
Apr. 66	Waterton, Canada	14	F	1 yearling, 13 mature
		6	M	1 yearling, 5 mature
	Total	20		

During the spring of 1967 9 lambs were born, 7 from the Wyoming ewes and 2 from the Canadian ewes.

	Total	43		
Dec. 69	Banff, Ca.	9	F	mature
		1	M	mature
		2	M	yearling
	Total	12		
Jan. 70	Banff, Ca.	6	F	mature
		3	F	yearling
		4	M	yearling
		1	M	mature
	Total	14		
	Grand Total	69		

TABLE 5 Known mortalities both to sheep in the enclosure and those escaped.

Number	Cause of Mortality
1	Stress related to handling
1	Self injury
5	Disease (pneumonia)
1	Sacrifice for bacterial culture
4	Illegally shot
5	Unknown
1	"Winter loss"

*Number remaining unaccounted for, 51.

Sightings in the respective units and areas outside the study area - The sighting information was gathered primarily from the files of the Utah Division of Wildlife Resources, Northern Region. U.S.F.S. personnel, one newspaper article, contacts with hunters during late October and contacts with local residents provided the remainder of the information. It is presented here in table form.

TABLE 6 Wellsville Unit

Date	No.	Sex	Location and Remarks	Source
Summer (1967)	5	?	North of Sardine Canyon near the "B" on the face of the mountain	Public
	7	?	Bakers Canyon, 1 mile north of Brigham City	Public
	8	?	Behind Harper's Ward church 3 miles north of Brigham City	Public
	1	M	Underneath reflectors on top of mountain north of Sardine Canyon	Public
4/15/69	1	M	Wellsville ridge above Box Elder Canyon	Salt Lake Tribune
8/2/71	1	F	1 mile east of the overpass at the mouth of Box Elder	DWR
6/-/72	1	F	Above gun range north of Mantua	Public
1/-/74	3	Adults	Box Elder Canyon, north side of highway	Public
	2	Lambs		
7/-/76	2	F	Spring at head of Brushy Canyon near Wellsville Cone	Public
	1	Lamb		

TABLE 7 Willard - Ben Lomond Peaks Unit

Date	No.	Sex	Location and Remarks	Source
April 67	1	F	East of Vicky's Cafe (near Willard, Utah)	Public
7/20/67	1	M	Willard Peak	Public
8/10/67	1	M	Between Ben Lomond and Willard Peak	Public
	4	F		
	3	Lambs		
10/-/67	1	F	Found shot in picnic area near Willard Peak	DWR
10/-/67	2	M	Willard Peak Area	DWR
	5	F		
	2	Lambs		
12/-/67	1	M	Found 1/2 mile north of Rulon White's	DWR
12/-/67	3	F	Same general area	DWR
3/7/68	2	M	Above canal at Willard	DWR
	3	F		
	1	Lamb		
4/-/68	1	F	Found dead above Vicky's Cafe	DWR
7/21/68	1	M	Willard Peak	Public
	2	F		
	2	Lambs		
4/23/69	1	M	Dead (shot) South Willard Bench	DWR
Summer (1969)	2	M	Willard Basin	Public
Summer (1969)	1	M	West side of Willard Peak	Public

TABLE 7 (Con'd.)

Date	No.	Sex	Location and Remarks	Source
Summer (1969)	2	M	In cliffs on Willard Peak	Public
8/-/69	5	M	Willard Basin	U.S.F.S.
8/-/69	9	F?	Willard Basin	U.S.F.S.
	1	Lamb		
8/7/69	1	M	West face of Willard Peak	U.S.F.S.
	2	F		
9/7/70	1	M	Southwest side of Ben Lomond Peak	Public
10/3/70	5	F	Willard Peak	DWR
8/-/71	1	M	Between Willard and Ben Lomond Peak	U.S.F.S.
2/-/72	1	M	Above Maddox at or near snowline on west slope	Public
2/-/72	1	F	Dead (winterloss) above Maddox Drive-in	DWR
7/-/73	8	?	South face of Ben Lomond Peak	Public
8/-/73	1	M	South face of Ben Lomond Peak	Public
8/-/73	1	M	Chilly Peak	Public
Fall (1973)	1	M	North Ogden Canyon north side of highway	Public
10/-/73	1	F	Illegal kill location not stated	DWR
11/-/73	1	F	Inspiration Point	DWR
	1	M		
	1	Lamb		
4/-/74	1	F	North 1/4 mile from Willard Peak	U.S.F.S.
6/-/74	1	F	Canal (dead, cause unknown) east of Pettingill's Fruit Farm in South Willard	DWR

TABLE 7 (Con'd.)

Date	No.	Sex	Location and Remarks	Source
4/-/75	1	F	North 1/4 mile from Willard Peak	Public
	1	Lamb		
9/-/66	1	F	Dead (shot) in bighorn sheep enclosure	DWR

TABLE 8 Bighorn Sheep Enclosure Area

Date	No.	Sex	Location and Remarks	Source
Summer (1967)	2	?		Public
10/-/70	1	M		DWR
1/-/70	3	M		DWR
	4	F		DWR
	2	Lamb		DWR
12/-/70	4	M		DWR
7/26/71	1	F		DWR
	2	M		DWR
7/27/71	4	M		DWR
	3	F		DWR
	1	Lamb		DWR
8/-/71	1	F		DWR
2/-/72	5	M		DWR
	3	F		DWR
	6	?		DWR
6/-/75	1	M		DWR

TABLE 9 Mount Ogden Unit

Date	No.	Sex	Location and Remarks	Source
11/-/73	1	M	Weber Canyon above Interstate 80	Utah Power & Light Emp.
11/-/73	1	M	Weber Canyon above Interstate 80	U.S.F.S.

TABLE 10 Sightings Outside of the Study Area

Date	No.	Sex	Location and Remarks	Source
Summer (1967)	12	?	Alfalfa field near Mantua	Public
Summer (1967)	12	?	Dry lake area	Public
9/26/67	1	M	Near National Guard Station on Francis Peak	Nat. Gd. Personnel
	1	F		
	1	Lamb		
12/26/68	1	M	In town of Mantua	DWR
10/-/70	1	M	Mixed with a band of domestic sheep near girl scout camp near Mantua	DWR
11/-/71	2	F	Inside the town of Mendon	Public
1/-/72	1	F	Inside the fence at the Intermountain Indian School	DWR

Efforts to Locate the Escaped Mountain Sheep

Prior to and during this study several attempts were made to locate the escaped bighorn sheep on the study area. The date, area searched, and approximate time spent in the search are given in Table 11. No sheep were located during the searches.

TABLE 11

Date	Area	Approximate Time Spent
Early September 1975	Cutler Basin and the E. face of Willard Peak	3 hours
Mid September 1975	Same as above	4 hours
24 October 1976	Cutler Basin, Willard Peak and Ben Lomond Peak	1 day
29 October 1976	Wellsville Cone	1 day
10 November 1976	Bighorn Sheep Enclosure	1/2 day
13 November 1976	N. side of Weber Canyon	1/2 day
15 November 1976	Bighorn Sheep Enclosure	1 day
25 November 1976	Pearson's Canyon	3 hours
2-5 December 1976	Wellsville Crest	3 1/2 days
11 December 1976	South end of Wellsville	1 day
12 December 1976	North Ogden Divide north to and including Ben Lomond Peak and Cutler Basin	1 day

During March of 1975 the Utah Division of Wildlife Resources made an aerial search over the Wellsville and Willard - Ben

Lomond Peaks Units. No mountain sheep were located. Another flight was made during the following summer. One mature ram was located in the bighorn sheep enclosure near Brigham City.

Success or Failure to Establish

Reduced numbers of sightings in 1975-76 and failure of aerial surveys to locate the escaped bighorn sheep indicate that the transplanted population has not established. Considering records of successful transplants in other states, the bighorn population on the study area should have shown a notable increase by this date.

Probable causes for failure to establish are human disturbance, low quality breeding stock, and uncontrolled release. A few of the animals were known to have been shot. Considerable human activity occurs in prime foraging and watering sites near the release area. The majority of the stock were from a Canadian population with a history of low reproduction and recruitment. The uncontrolled release prevented the sheep from adopting the enclosure area as part of their home range and further made control of disease, natural predation, and human disturbance impossible.

V. EVALUATION OF THE STUDY AREA FOR BIGHORN SHEEP SUITABILITY

A. Methods of Evaluating the Vegetational Components of the Habitat and Predicting Bighorn Range.

The vegetation types used in this study are based on those outlined in the USFS, Region 4 Range Environmental Analysis Handbook and the Utah Division of Wildlife Resources Big Game Inventory, 1970 and 1971.

1. All units of the study area were visited to determine what vegetation types existed. The most obvious plant species were identified or collected for identification. Notes were made on elevation, exposure, and association of different plants and vegetation types. A literature review was made to determine what vegetation types had been used on occupied bighorn ranges.

2. Representative types were photographed at close range to make distinction of prominent species in the type visible. Distant photographs were made from elevated positions and along the west base of the Wasatch Front to allow determination of relation of the various types.

3. Aerial photographs were viewed to determine what vegetation types could be distinguished.

4. Sighting information was used as an aid in determination of range boundaries. Also the Rocky Mountain Bighorn Sheep Map prepared by Jim Kimbal (1969) was used in selection of range limits.

5. Field checks were made on types delineated on aerial photographs.

Criteria used to determine bighorn range on the study area:

1. Mountain sheep range primarily in steep broken terrain.

2. Dense mountain brush and timber are avoided.

3. Large areas of sheer cliffs are of low value and were given a non-type classification.

4. Large patches of dense brush on north slopes of the west side were classed as non-type due to their expected low value. Dense mountain brush cover of the east slope was not mapped.

Mapping and Area Determination

Vegetation types were delineated on aerial photographs ELK series 6-23-63, 1:1580 scale. Vegetation type boundaries

were transferred to a two-inch to the mile planimetric base map. Deer winter ranges were drawn on the map to show overlap with predicted bighorn winter ranges. Acreages of summer and winter ranges were determined plus acres of overlap between deer and bighorn sheep.

Determination of Production

Collection of range data was beyond the scope of this study. Existing studies of the USFS and the Division of Wildlife Resources were used for production estimates of the various vegetation types in the study area.

*Estimate of Bighorn Sheep/Months

Criteria and assumptions:

1. Bighorn sheep and deer require about 4.5 lbs. forage/day.

2. On winter range in the study area, deer are the only recognized competitor for forage.

* Due to behavioral characteristics such as palatability preference for certain forage species and environmental factors such as impassible terrain, distance to water and escape cover, much forage would not be utilized. Thus, actual sheep months would be much lower than estimated sheep months.

3. Differences in deer and bighorn food preferences are ignored on overlapping ranges.

4. Allowance is made for 60% utilization.

5. Literature sources were used to evaluate plant species for bighorn use. Species not mentioned in the literature were evaluated by their known use by other big game and domestic livestock. Palatable species by dry weight were added to give total palatable production.

6. Palatable pounds of production for bighorn sheep only, allowing for 60% utilization, is used on winter range acreages not used by deer.

7. Although predicted winter range acreages are greater than or nearly equal to predicted summer ranges, forage quality and quantity is expected to be less. Portions of the winter range will be covered with snow following storms resulting in less available forage for bighorn sheep. Due to dormancy of many plants, palatability and quantity will be less than the average production figure used in determining forage quantity. Deer will be more concentrated on the winter range resulting in greater competition for forage.

B. Vegetation Types (see figures 1 through 4)

Subalpine Forb (3)

This type occurs in the study area at the highest elevations on north and east facing slopes. Included within this type are the rough, rocky, barren communities. However, some basins supporting this type produce fairly lush vegetation. All units except the Lewis Peak Unit have measurable amounts of this type. The common species are:

grasses - Stipa lettermanii, Agropyron trachycaulum, Bromus carinatus, Poa secunda, Koleria cristata, Festuca therberi, and Sitanion hystrix;

forbs - Achilles lanulosa, Aster spp., Agastache urticifolia, Lupinus spp., Geranium fremontii, Castillega spp., and Penstemon cyananthus;

browse - Artemesia tridentata vaseyana, Holodiscus dumosus, Symphoricarpos spp., Eriogonum heracleoides, and Artemisia arbuscula arbuscula.

Composition (1)

Vegetation		Ground Cover	
Grass	10%	Vegetation and Litter	42%
Forbs	51%	Rock and Pavement	48%
Browse	39%	Bare Ground	10%

Average pounds per acre dry weight - 312 (1)

Mountain Sagebrush (4M)

This type is found on all 4 units at elevations usually above 7,000 feet. Generally it occurs only along or near the ridge tops. Such ridges that are swept free of snow would provide mountain sheep with winter forage. The remainder is considered summer range. The common species are:

grasses - Stipa lettermanii, Bromus carinatus, Agropyron spp., Festuca therberi, Koeleria cristata, and Poa spp.;

forbs - Achillea lanulosa, Aster spp., Arenaria aculeata, Senecio spp., and Monordella odoratissima;

browse - Artemisia tridentata vaseyana, Artemisia arbuscula arbuscula, Symphoricarpos spp., Eriogonum heracleoides, and Prunus virginiana.

Composition (1)

Vegetation		Ground Cover	
Grass	12%	Vegetation and Litter	41%
Forbs	27%	Rock and Pavement	20%
Shrubs	61%	Shrubs	61%

Average pounds per acre dry weight - 706(1)

Sagebrush-grass (4G)

This type is found at the foot of the study area's west slope. It extends south from Box Elder Canyon to Pine Canyon at the west foot of Ben Lomond Mountain. Usually it is confined to the lowest elevations (4,400 feet) of the study area. Use would be expected to be greatest during deep snows and during spring green up. The common species are:

grasses - Agropyron spicatum, Agropyron inerme, Bromus tectorum, Poa pratensis, and Poa secunda;

forbs - Achillea lanulosa, Ambrosia psilostachy, Artemisia ludoviciana, Aster Chilensis, and Euphorbia spp.;

browse - Artemisia tridentata, Gutierrzia sarothrae, Chrysothamnus nauseosus, and Prunus virginiana.

Composition (2)

Vegetation		Ground Cover	
Grass	15%	Vegetation and Litter	70%
Forbs	18%	Rock	8%
Browse	67%	Bare Ground	22%

Average pounds per acre dry weight - 788

Sagebrush (4)

This type is found between 4,500 feet and 6,000 feet on the Wellsville Unit. Use of this type is expected to occur during deep snow and spring green up. The common species are:

grasses - Agropyron spicatum, Poa nevadensis, Sporobolus cryptandrus, and Poa secunda;

forbs - Achillea lanulosa, Arenaria congesta, Artemisia ludoviciana, Crypthantha spp., Descurainia sophia, Erodium circutarium, and Helianthus annus;

browse - Artemisia arbuscula nova, Artemisia tridentata, Berberis repens, Gutierrezea sarothrae, and Rhus glabra.

Composition (3)

Vegetation		Ground Cover	
Grass	25%	Vegetation and Litter	60%
Forbs	18%	Rock	15%
Browse	57%	Bare Ground	25%

Average pounds per acre dry weight - 393 (3)

Sparse Sagebrush (4S)

This type occurs south of Pine Canyon on the west face of Ben Lomond Mountain to Weber Canyon. It is limited to the lower elevations, mostly below 5,000 feet. It is considered winter range only. The common species are:

grasses - Agropyron spicatum, Aristida longiseta, Sitanion hystrix, and Stipa comata;

forbs - Ambrosia psilostachya, Artemisia ludoviciana, Lactuca serriola, and Lupinus caudatus;

browse - Artemisia tridentata, Gutierrezia sarothrae, Opuntia spp., and Sambucus cerula.

Composition (4)

Vegetation		Ground Cover	
Grass	18%	Vegetation and Litter	78%
Forbs	37%	Rock	9%
Browse	45%	Bare Ground	13%

Average pounds per acre dry weight - 522(4)

Browse* (5)

This type is found primarily above the sagebrush types of lower elevations and extends up to the ridge tops in some situations. Generally, though, it is below the open conifer and mountain sagebrush types. It is found on all units of the study area. The common species are:

* For the purposes of this study, the browse-sagebrush type described in Utah Division of Wildlife Resources Big Game Range Inventory 1971, Unit 7, is included in the browse type.

grasses - Agropyron spicatum, Agropyron inerme, Aristida longiseta, Bromus commutatus, Bromus japonicus, Poa pratensis, and Poa secunda;

forbs - Achillea lanulosa, Apocynum androsae, Artemisia ludoviciana, Aster spp., Epilobium spp., and Balsamorhiza sagittata;

browse - Acer grandidentatum, Artemisia tridentata, Berberis repens, Prunus virginiana, Quercus gambelli, Rhus radicans, and Guitierrezia sarothrae.

Composition (4)

Vegetation		Ground Cover	
Grass	9%	Vegetation and Litter	77%
Forbs	19%	Rock	12%
Browse	72%	Bare Ground	11%

Average pounds per acre dry weight - 750(4)

Open Conifer

This type is found mostly above 6,000 feet on north facing slopes. Due to heavy snow pack of winter it is limited to summer range. The common species are:

grasses - Stipa lettermanii, Bromus carinatus, and Poa spp.;

forbs - Aster spp., Geranium fremontii, Potentilla glandulosa, and Agastache urticifolia;

browse - Pachistima myrsinites, Ribes montigium, Symphoricarpos spp., and Eriogonum heracleoides.

Composition (1)

Vegetation		Ground Cover	
Grass	3%	Vegetation and Litter	68%
Forbs	32%	Rock and Pavement	27%
Browse	65%	Bare Ground	5%

Average pounds per acre dry weight - 737(1)

Juniper (9)

This type is found along the west slope of the Wellsville Unit. It ranges from about 5,000 feet up to about 7,000 feet and is situated between the sagebrush type (4,500 feet)

bottom, and the mountain sagebrush type of the ridge tops. It occurs mainly on south and west exposures. Use of this area is expected during winter and spring green up. The common species are:

grasses - Agropyron inerme, Agropyron subsecundum, Aristida longiseta, Bromus marginatus, and Sporobolus cryptandrus;

forbs - Artemisia ludoviciana, Balsamorhiza sagittata, Cirsium spp., Commandra pallida, Hackelia floribunda, and Linum lewsi;

browse - Artemisia tridentata, Berberis repens, Chrysothamnus stenophyllus, Gutierrezia sarothrae, and Juniperus osteosperma.

Composition (3)

Vegetation		Ground Cover	
Grass	29%	Vegetation and Litter	57%
Forbs	32%	Rock	26%
Browse	65%	Bare Ground	17%

Average pounds per acre dry weight - 907 (3)

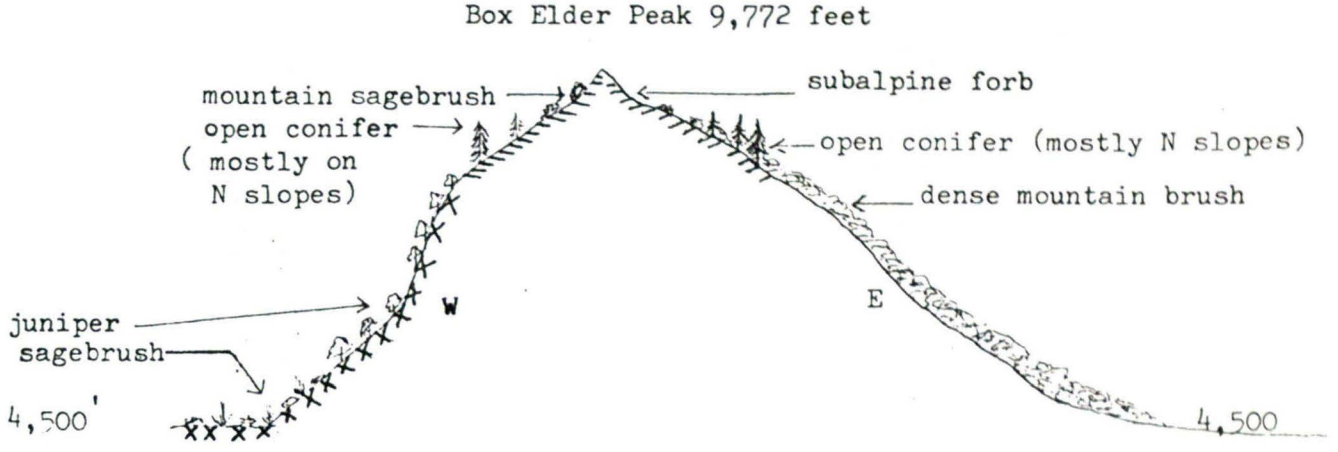

Figure 1. WELLSVILLE UNIT

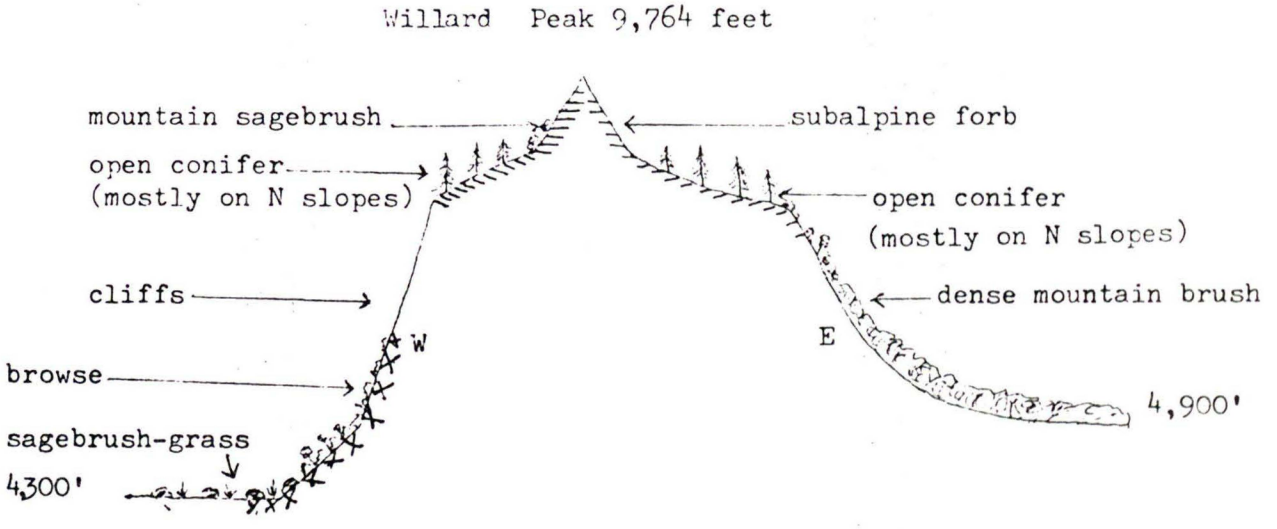

Figure 2. WILLARD -BEN LOMOND PEAK UNIT

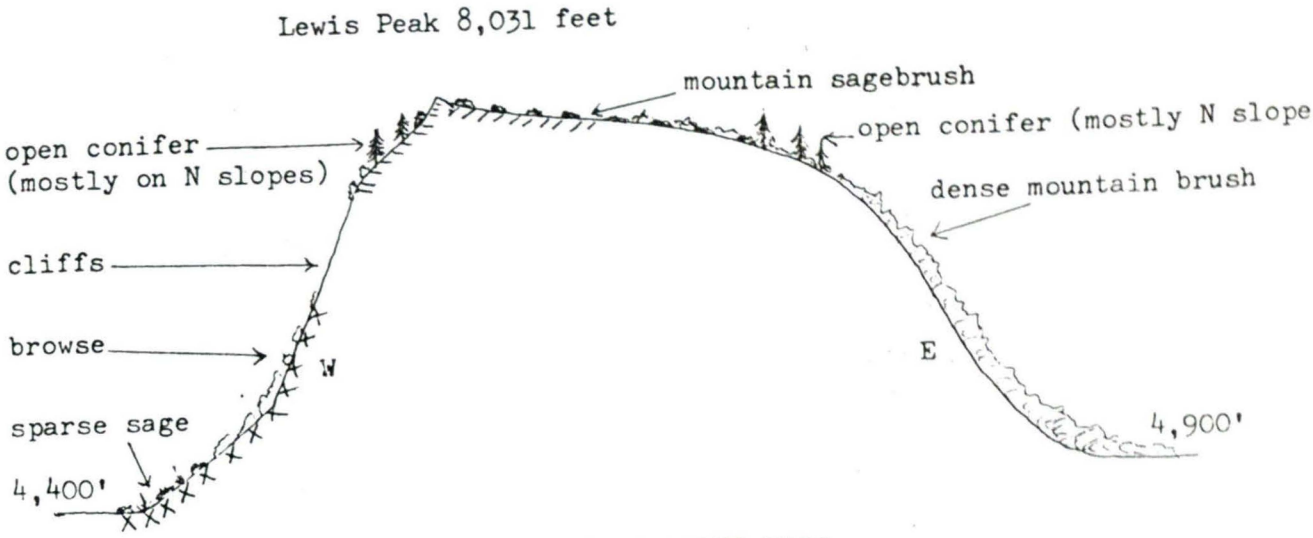

Figure 3. LEWIS PEAK UNIT

Summer Range →

Winter Range →

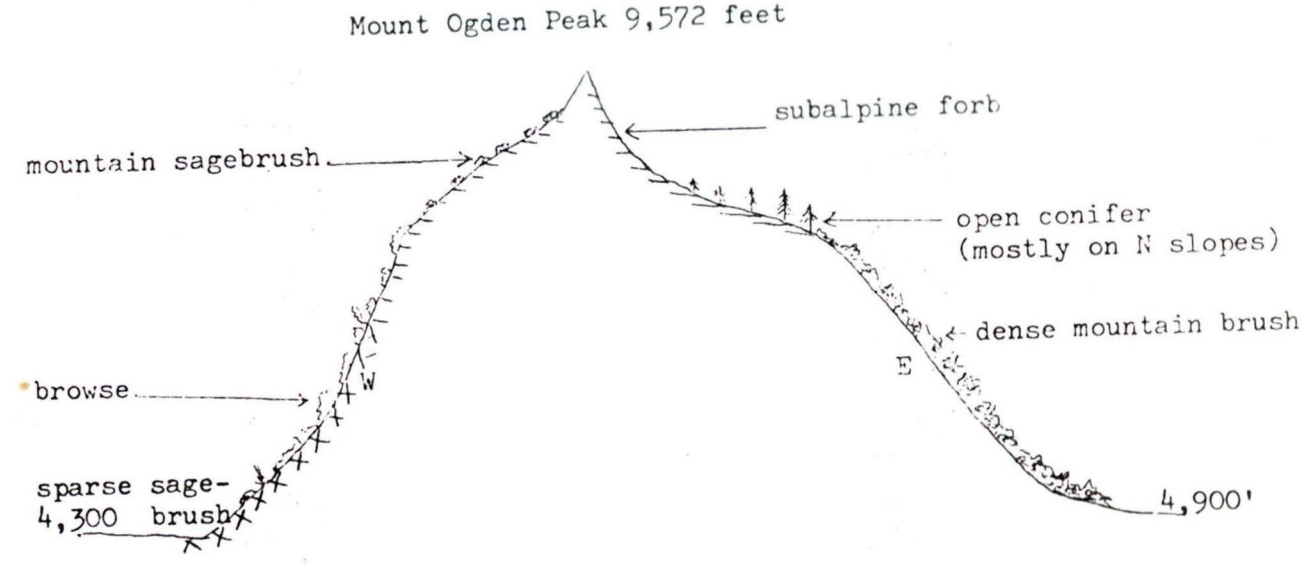

Figure 4. MOUNT OGDEN UNIT

1. Kimbal, Savage, and Worthen (1972) Rocky Mountain Bighorn Habitat Study, pages 3, 4, and 5.

2. Utah Division of Wildlife Resources Big Game Range Inventory, 1970, Unit 3.

3. Utah DWR (ibid.) Unit 4.

4. Utah DWR Big Game Range Inventory, 1971.

C. Evaluation of the Study Area by Unit

Discussion

The units are evaluated here as to their respective qualities for water, cover and food. In addition, human activity in each unit is indicated. These factors are described as follows:

1. Dry season water sources - late summer until first snow fall that is sufficient to feed intermittent springs at the higher elevations. Transplanted bighorn sheep are not expected to seek out water sources in non-typical terrain.

2. Rugged rocky escape terrain - only summer ranges are evaluated since it is believed that suitable escape terrain exist on most of the winter ranges. This terrain is characterized by steep to sheer cliff rock formations. It is irregular in shape and often jagged in appearance.

3. Acreages of the vegetation types and estimated production in pounds dry weight. These types are separated into two groups: (a) types typical of summer range and (b) types typical of winter range. However, some types occur on both predicted summer and winter range.

4. Estimate of bighorn sheep units allowing for competition from deer on the winter range. Due to lack of information competition from deer cannot be estimated for summer ranges. Except for browse type, pounds of production on the summer range is used as palatable pounds of production allowing for 60% utilization. Only palatable plants (bighorn sheep) are considered in the browse type on summer range. Palatable pounds of forage on winter range has been determined by methods discussed in part A "Estimate of bighorn sheep months."

5. Estimated visitor day use - a visitor-day consists of 12 visitor hours, which may be aggregated continuously, intermittently, or simultaneously by one or more person. Forest Service Recreation Information Management Handbook, 124-2, Dec. 73, AMEND. 35.

Wellsville

1. Dry season water sources - only one known water source exists on the summer range. This is a spring located at the head of Brushy Canyon just south of the Wellsville Cone. Other sources are located down in the mountain brush zone. Camping activity at the spring may exclude use by bighorn.

2. Rugged rocky escape terrain - Box Elder Peak and the Wellsville Cone have adequate escape terrain, but some of the lower ridges that reach north and south from these peaks are lacking. Use of these ridges may be limited.

3. Acreages and average pounds production for the vegetation types are presented in Tables 12 and 13.

(See Tables 12 and 13 on next page.)

TABLE 12 Vegetation types found on summer range in acres and lbs./acre dry weight

Type	(3) Subalpine forb	(4M) Mountain sagebrush	(5) Browse	(6) Open conifer
$\bar{x}$	312	706	976	737
acres	821	1,394	2,350	4,321
production lbs.	256,152	984,164	2,293,600	3,184,577

Total acres of summer range 8,886

Total pounds production 6,718,493

TABLE 13 Vegetation types found on winter range in acres and lbs./acre dry weight

Type	(4) Sagebrush	(4M) Browse	(9) Juniper
$\bar{x}$ lbs./acre	393	976	907
acres	2,269	1,889	4,442
production lbs.	891,717	1,843,664	4,028,894

Total acres of winter range 8,600

Total pounds production 6,764,275

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4. Estimate of bighorn sheep units are presented in Tables 14 and 15.

TABLE 14 Estimated bighorn sheep units, summer range

Total lbs. useable production		*Average bighorn sheep unit		Total bighorn sheep units
3,751,116	$\div$ x	950 lbs.	=	3,949*

*Assuming that on the average, a bighorn sheep will require 4.5 lbs./day for 211 days on the winter range. Thus, a bighorn sheep unit = 4.5 lbs./day times 211 days - 949.5 lbs. or approximately 950 lbs. per sheep on the winter range.

(See Table 15 on next page.)

TABLE 15 Estimated bighorn sheep units on winter range allowing for competition with mule deer.

USED BY	Bighorn Sheep		Mule Deer		Bighorn Sheep	
VEGETATION TYPE	(4)	(9)	(4)	(5)	(9)	Total
Useable lbs. palatable production	113,288	80,169	355,093	916,958	1,560,125	3,025,633
*Forage Utilized by mule deer			256,029	283,161	623,584	1,162,774
Unused forage available to bighorn sheep	113,288	80,169	99,064	633,797	936,541	1,862,859
Bighorn sheep units	119	84	104	667	986	1,960*

*Based on the Cold Water Canyon Transect covering a 6-year period = average of 33.3 deer days/acre x 4.5 lbs. per deer = 149.9 lbs. used per acre.

5. Visitor day use - no estimates of visitor day use exist for the Wellsville Unit. It is light relative to the other three units. Access to this unit is not highly developed. Travel is mainly limited to foot or horseback except for the north and south ends where jeep trails reach up to the crest of the unit. Surrounding populations are not as great as those of the other three units.

Willard - Ben Lomond Peaks

1. Dry season water sources - several water sources are available: Perry Reservoir, the creek at the head of Perry Canyon, Willard Peak Pond, Cutler Spring, Cutler Pond, and Cutler Creek. Some sources that are used by campers may exclude use by bighorn. However, water is not expected to be critical in this unit.

2. Rugged rocky escape terrain - adequate escape cover exists on Willard and Ben Lomond Peaks. Also many of the ridges provide broken terrain and numerous rocky outcrops for escape cover.

3. Acreages and average pounds production for the vegetation types are presented in Tables 16 and 17.

(See Tables 16 and 17 on next page.)

TABLE 16 Vegetation types found on summer range in acres and lbs./acre dry weight

Type	(3) Subalpine forb	(4M) Mountain sagebrush	(5) Browse	(6) Open conifer
$\bar{x}$ lbs./acre	312	706	563	737
acres	1,248	1,184	1,003	4,559
production lbs.	389,376	835,904	564,689	3,359,983
Total acres of summer range	7,994			
Total pounds production	5,149,952			

TABLE 17 Vegetation types found on winter range in acres and lbs./acre dry weight

Type	(4G) Sagebrush-grass	(5) Browse
$\bar{x}$ lbs./acre	788	563
acres	1,358	7,130
production lbs.	1,070,104	4,014,190
Total acres of winter range	8,488	
Total pounds production	5,084,294	

4. Estimate of bighorn sheep units are presented in Tables 18 and 19.

TABLE 18 Estimated bighorn sheep units, summer range

Total lbs. useable production		Average bighorn sheep unit		Total bighorn sheep units
2,936,578	$\dot{\times}$	950 lbs.	=	3,091

(See Table 19 on next page.)

TABLE 19 Estimated bighorn sheep units on winter range allowing for competition with mule deer.

USED BY	Bighorn Sheep		Mule Deer	Bighorn Sheep	
VEGETATION TYPE	(4G)	(5)	(4G)	(5)	Total
Useable lbs. palatable production	154,423	337,018	395,364	1,013,743	1,900,548
*Forage Utilized by mule deer			107,432	585,362	692,794
Unused forage available to bighorn sheep	154,423	337,018	287,932	428,381	1,207,754
Bighorn sheep units	163	355	303	451	1,272

*Based on the South Willard (5 yr. period), Perry Bench (6 yr.), Perry Basin (6 yr.), Perry Canyon (6 yr.), and the North Ogden Canyon (5 yr.) transects = average of 24.52 deer days/acre x 4.5 lbs. per deer = 110.3 lbs. used per acre.

5. Visitor day use is presented in Table 20.

TABLE 20 Visitor Day Use* for the Willard-Ben Lomond Peaks Unit

Activity	Day Use in Thousands
Motorcycle	6.0
Hiking	4.4
Horseback Riding	4.7
Snowmobile	1.6
Camping, general	6.5
Hunting big game	0.8
Hunting upland birds	0.4

* Ogden Ranger District, USFS Use Source Document for Calendar Year 1976.

Lewis Peak

1. Dry season water sources - in order for sheep to use the higher elevations of this unit they would be expected to have to travel to and from water sources down in the brushy canyons. No known spring or seeps occur along or near the ridge tops.

2. Rugged rocky escape terrain - this unit is lacking in suitable escape terrain at its highest elevations supporting open vegetation types typical to bighorn summer range.

3. Acreages and average pounds production for the vegetation types are presented in Tables 21 and 22.

(See Tables 21 and 22 on next page.)

TABLE 21 Vegetation types found on summer range in acres and lbs./acre dry weight.

Type	(3) Subalpine forb	(4M) Mountain sagebrush	(5) Browse	(6) Open conifer
$\bar{x}$ lbs./acre	312	706	528	737
acres	0	209	47	694
production lbs.		147,554	24,816	511,478
Total acres of summer range	950			
Total pounds production	683,848			

TABLE 22 Vegetation types found on winter range in acres and lbs./acre dry weight.

Type	(4S) Sparse sagebrush	(5) Browse
$\bar{x}$ lbs./acre	522	528
acres	381	3,909
production lbs.	198,882	2,063,952
Total acres of winter range	4,290	
Total pounds production	2,262,834	

4. Estimate of bighorn sheep units are presented in Tables 23 and 24.

TABLE 23 Estimated bighorn sheep units, summer range.

Total lbs. useable production		Average bighorn sheep unit		Total bighorn sheep units
406,848	$\div$ x	950 lbs.	=	428

(See Table 24 on next page.)

TABLE 24 Estimated bighorn sheep units on winter range allowing for competition with mule deer.

USED BY	Bighorn Sheep		Mule Deer	Bighorn Sheep	
VEGETATION TYPE	(4S)	(5)	(4S)	(5)	Total
Useable lbs. palatable production	0	171,921	95,540	838,588	1,106,049
*Forage utilized by mule deer			42,024	353,181	395,205
Unused forage available to bighorn sheep		171,921	53,516	485,407	710,844
Bighorn sheep units		181	56	511	748

*Based on the average of transects located on the South Willard Bench, Perry Bench, Perry Basin, Perry Canyon, and North Ogden Canyon. The average of 24.52 deer days/acre x 4.5 lbs. per deer - 110.3 lbs. used per acre.

5. Visitor day use is presented in Table 25.

TABLE 25 Visitor Day Use in the Lewis Peak Unit.

Activity	Day Use in Thousands
Motorcycle	2.4
Hiking	1.4
Horseback Riding	2.2

Mount Ogden

1. Dry season water sources - water is available in Malan's Basin and Chicken Spring. Mountain sheep may be excluded from water sources in Malan's Basin due to overnight camping.

2. Rugged rocky escape terrain - excellent escape terrain exists along the crest of this unit.

3. Acreages and average pounds production for the vegetation types are presented in Tables 26 and 27.

(See Tables 26 and 27 on next page.)

TABLE 26 Vegetation types found on summer range in acres and lbs./acre dry weight.

Type	(3) Subalpine forb	(4M) Mountain sagebrush	(5) Browse	(6) Open conifer
$\bar{x}$ lbs./acre	312	706	528	737
acres	840	472	1,222	1,818
production lbs.	26,208	333,232	645,216	1,339,866
Total acres of summer range	4,347			
Total pounds production	2,344,522			

TABLE 27 Vegetation types found on winter range in acres and lbs./acre dry weight.

Type	(4S) Sparse sagebrush	(4M) Mountain sagebrush	(5) Browse
$\bar{x}$ lbs./acre	248	706	528
acres	47	0	5,100
production lbs.	11,656		2,692,800
Total acres of winter range	5,147		
Total pounds production	2,704,456		

4. Estimate of bighorn sheep units are presented in Tables 28 and 29.

TABLE 28 Estimated bighorn sheep units, summer range.

Total lbs. useable production		Average bighorn sheep units		Total bighorn sheep units
1,458,261	$\div$ x	950 lbs.	=	1,535

(See Table 29 on next page.)

TABLE 29 Estimated bighorn sheep units on winter range allowing for competition with mule deer.

USED BY	Bighorn Sheep		Mule Deer	Bighorn Sheep	
VEGETATION TYPE	(4S)	(5)	(4S)	(5)	Total
Useable lbs. palatable production	0	558,900	11,797	735,925	1,306,622
*Forage Utilized by mule deer			5,184	309,943	1,621,749
Unused forage available to bighorn sheep		558,900	6,613	1,045,868	1,611,381
Bighorn sheep units		588	7	1,101	1,696

*Based on the average of transects located on the South Willard Bench, Perry Bench, Perry Basin, Perry Canyon, and North Ogden Canyon. The average of 24.52 deer days/acre x 4.5 lbs. per deer = 110.3 lbs. used per acre.

5. Visitor day use is presented in Table 30.

TABLE 30 Visitor Day Use in the Mount Ogden Unit.

Activity	Day Use in Thousands
Motorcycle	0.3
Snowmobile	0.2
Hiking	1.0
Horseback Riding	0.3

D. Conclusion to the Evaluation

1. The Wellsville Unit has considerable bunch grass occurring on the winter range. It appears that sufficient open vegetation types of mountain sagebrush and forbs occur on the summer range to support a population of mountain sheep. Although water may limit bighorn use during late dry summers, this problem could be remedied by a water development. Some ridges lacking immediate broken rocky terrain may not be used by sheep, but for the unit as a whole this is not expected to be seriously limiting.

This unit is thought to offer the best opportunity to acclimate transplanted bighorn to a new environment with a minimum of disturbance on both summer and winter range.

Because of its relative large size, bunch grass associations, minimum development, relatively present low visitor useage, and low surrounding population, it ranked first of the 4 units as a potential transplant site.

2. The Willard-Ben Lomond Peak Unit has suitable habitat for bighorn sheep. Its size, relatively open vegetation types supporting large amounts of bunch grasses

and forbs, perennial water supplies, and rugged terrain make this unit superior to the others in terms of physical habitat. Yet it receives the greatest human use. Unless people management is possible this unit's value as an area for reintroduction is reduced.

3. The Mount Ogden Unit is ranked third as a suitable transplant area. Although this unit is believed to have excellent escape terrain, adequate water sources, and summer forage, bunch grass associations typical to native bighorn ranges are lacking. However, openings in browse type on winter range should provide enough preferred forage for a small population of mountain sheep. Except for the rugged Weber Canyon considerable uncontrolled human activity occurs on the winter range of this unit.

4. The Lewis Peak Area is not believed to have adequate habitat for establishment of bighorn sheep. Open vegetation types are lacking on both the predicted summer and winter ranges. Water sources and preferred vegetation types are not believed to be sufficient. Large numbers of people are active on the summer and winter ranges year round.

RECOMMENDATIONS

1. In order to enhance the esthetic values of the National Forest and to increase the range of a species that is relatively limited in its present day distribution, it is recommended that the U.S. Forest Service cooperate with the Utah Division of Wildlife Resources in reintroduction of Rocky Mountain Bighorn Sheep to the area considered in this report. Pending completion of an environmental analysis report, transplanting of bighorn sheep should be made in the near future due to increased human activity and development on or near the potential transplant sites. Additional stocking is necessary to insure a viable population for establishment.

2. The unit selected for transplanting should be managed with use allocated to bighorn sheep.

   a. Trails or roads should not be developed through the majority of open vegetation types of mountain sagebrush and subalpine forbs. These types are found primarily in basins and along ridgetops. No trail or road should be developed through the majority of the sagebrush types, juniper, or more open browse stands that are expected or observed to be important to bighorn sheep during snowcover.

   b. Trails should be located away from overlooks above basins supporting the subalpine forb vegetation type.

c. Trails and campsites should be developed away from springs or ponds that provide the only dry season water source in predicted bighorn sheep range. Where this situation already exists, a water development at the foot of a snow chute on one of the higher peaks is suggested.

d. Motorcycles and snowmobile use should be controlled in the predicted bighorn range of the unit selected for transplant. Areas that are determined to be preferred by the transplanted sheep should be permanently closed to use of motorcycles and snowmobiles.

e. To prevent harrassment problems and prevent damage to important forage areas on predicted bighorn range, all jeep trails within these areas should be closed.

f. Areas determined critical to the transplanted animals should be protected from low aircraft flights except for essential management purposes.

g. During the period of high visitor use, June through October, it would be highly desirable to have a Forest Service employee operate in the area most occupied by the transplanted sheep to control illegal shooting and harrassment. Observations of the mountain sheep should be recorded and include any interactions with humans.

h. During deep snow, transplanted bighorn are expected to move to the low extremities of the winter range. If possible, important areas should be located through observation or radio tagging. These areas should be frequently checked during occupation by mountain sheep to reduce harrassment and illegal killing.

i. Use of firearms should be restricted in the release area for at least one year from date of transplant. Thereafter, use of firearms should be limited to the hunting season. Antlered deer hunting only should be considered as a means to reduce mistaken killings of ewes. Target shooting and "plinking" should be permanently prohibited in areas expected to be important bighorn habitat.

j. Areas off the National Forest that show high use by transplanted sheep should be considered for land acquisition.

k. Sheep and cattle trespass should be strictly controlled on predicted bighorn range.

l. Other big game, particularly deer and elk, should be managed in respect to mountain sheep on the transplant area.

m. A delayed response to fire, when not threatening watershed values, should be considered as a means of improving or expanding bighorn sheep habitat.

3. If the selected area cannot be managed as a special area, any development that increases visitor day use should be discouraged. No further development of trails, roads, or campsites should be made in or adjacent to predicted bighorn sheep range. Jeep trails into the unit should be closed. Access should be limited to foot and horse travel.

SUMMARY

A biological evaluation has been made of a portion of the Wasatch Front for the reintroduction of Rocky Mountain Bighorn Sheep. A literature review of bighorn sheep characteristics, life history data, requirements and man-bighorn sheep relationships are discussed. An evaluation of habitat suitability and human activity for each unit is made. Suitable habitat for a potential transplant is believed to exist in the Wellsville and Willard-Ben Lomond Peaks Units. The Wellsville Unit is ranked first as a potential site for reintroducing bighorn sheep.

Cooperation with the Utah Division of Wildlife Resources in a bighorn sheep reintroduction program is recommended. To improve the chances of transplant success while allowing for increased visitor useage, special management is suggested.

APPENDIX

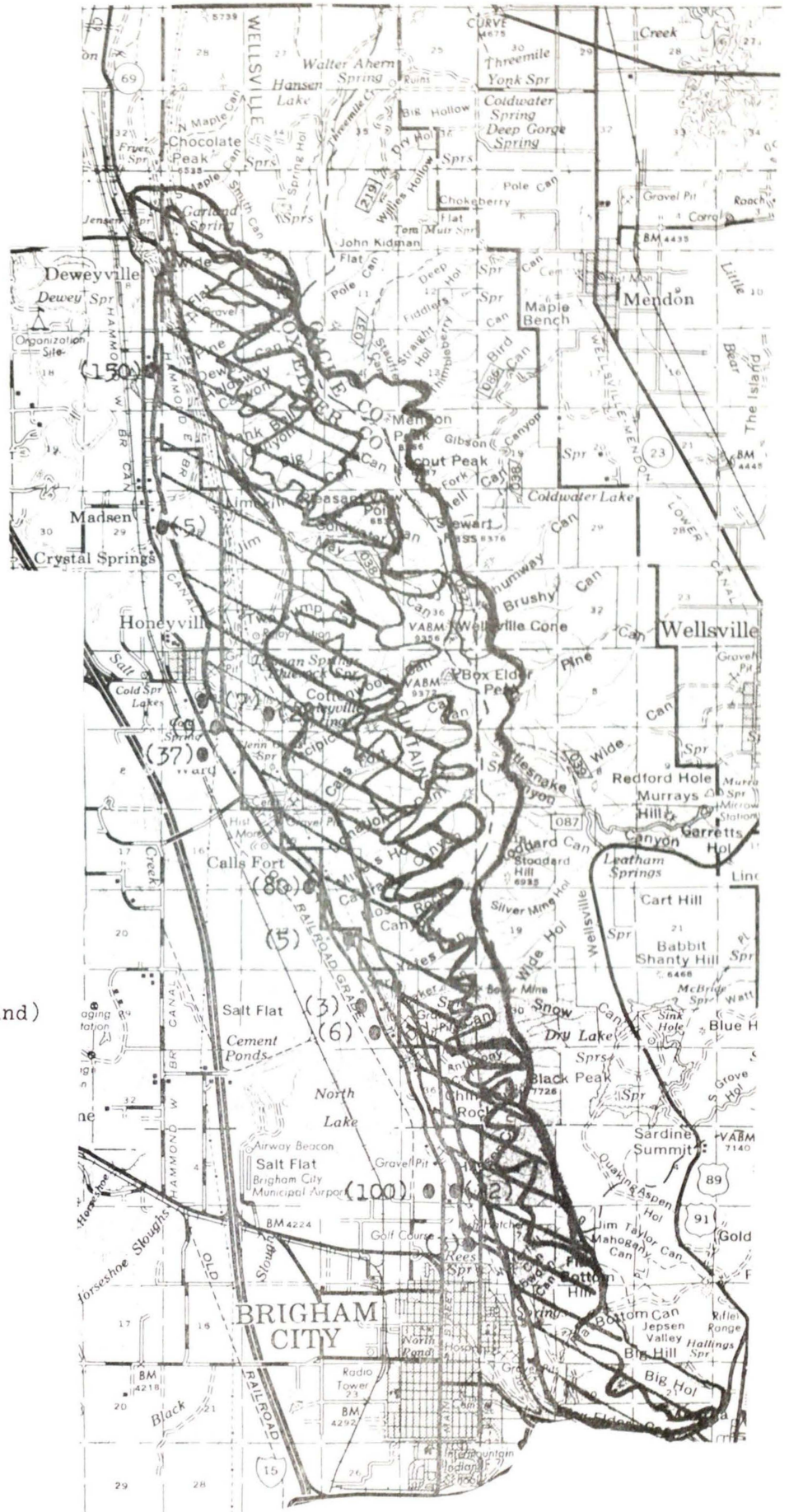
WELLSVILLE UNIT

BIGHORN SHEEP
SUMMER RANGE - blue
WINTER RANGE - red

DEER WINTER RANGE -

LOCATION OF DOMESTIC SHEEP BANDS

(approximate # of animals in band)



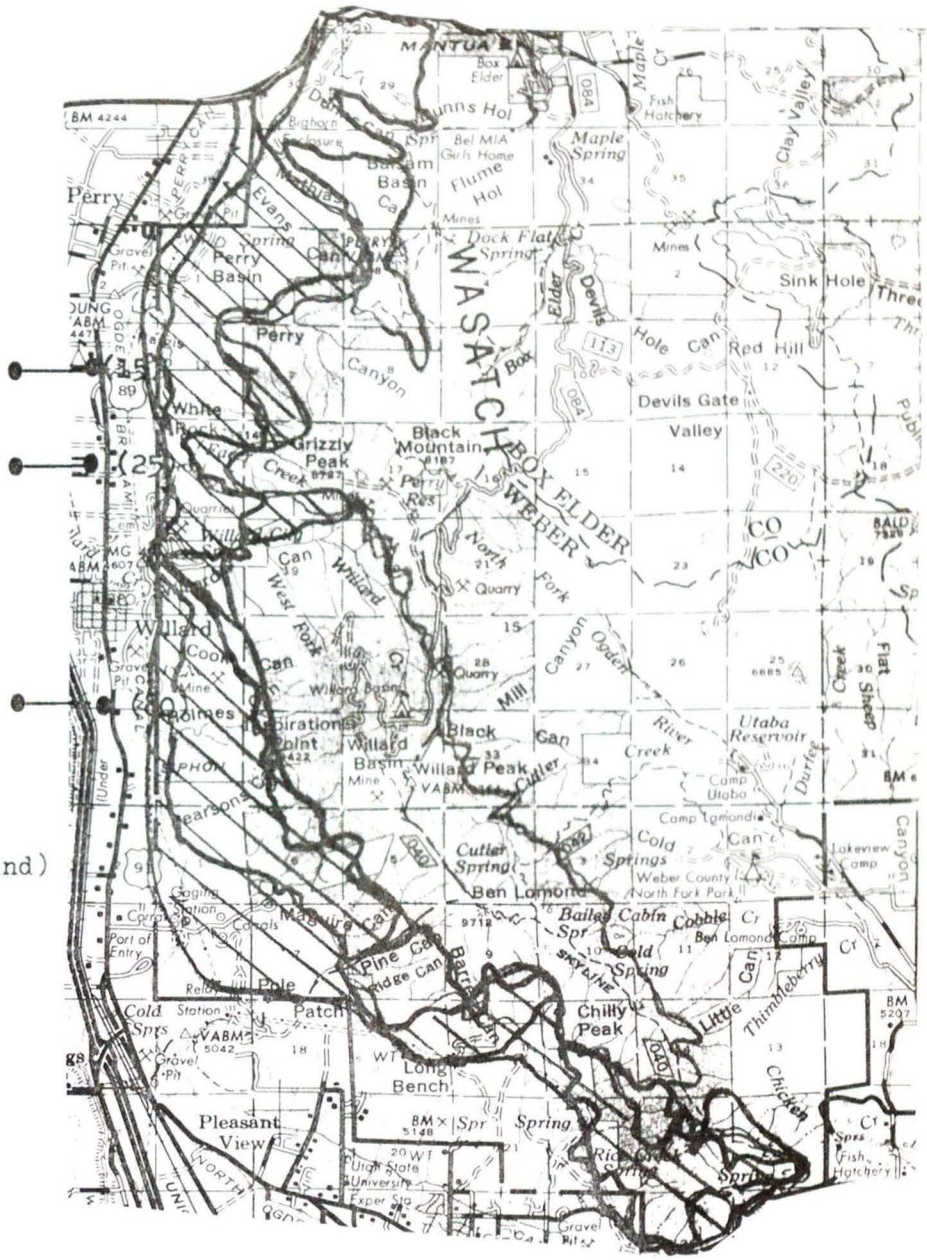
WILLARD-BEN LOMOND PEAKS UNIT

BIGHORN SHEEP
SUMMER RANGE - blue
WINTER RANGE - red

DEER WINTER RANGE -

LOCATION OF DOMESTIC SHEEP BANDS ●

(approximate # of animals in band)


WASATCH
BOX ELDER
WEBER
Perry
Willard
Willard Peak
Black Mountain
Grizzly Peak
Ben Lomond Peak
Ben Lomond
Pleasant View
Devils Gate
Valley
Red Hill
Sink Hole
Maple Spring
Dock Flat Spring
Cutler Spring
Cold Springs
Chilly Peak
Long Bench
Pole Patch
Cold Spgs
Utaba Reservoir
Camp Utaba
Camp Lomond
Ben Lomond Camp
Weber County North Fork Park
Lakeview Camp
Port of Entry
Willard Basin
Perry Basin
Flume Hol
Dunns Hol
Box Elder
Fish Hatchery
Bel MIA Girls Home
Evans Spring
Perry Spring
Bailey Cabin Spr
Gold Spring
Skyline
Thimbleberry
Chicken
Little
Cobble Cr
Pine Can
Ridge Can
Barrett Basin
Maguire Can
Pearsons Can
Cutler
Canyon
Creek
Fork
Mill
Quarry
Station
Gravel Pit
Spring
Utah State University
Exper Sta
Fish Hatchery
BM 4244
BM 5148
BM 5207
VABM 5042
20 WT
Maple
Elder
Devils
Box
Flat
Sheep
Durfee
Under
Relay
Station
Canals
Gaging
Mines
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Hill
Gate
Sink
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Thimbleberry
Chicken
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Cobble
Bailey
Cabin
Gold
Skyline
Ridge
Pine
Barrett
Maguire
Pearsons
Cutler
Utaba
Reservoir
Camp
Lomond
Lakeview
Weber
County
North
Fork
Park
Ben
Lomond
Peak
Cold
Springs
Chilly
Peak
Long
Bench
Pole
Patch
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Pleasant
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Gate
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Maple
Spring
Dock
Flat
Spring
Elder
Devils
Box
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Sheep
Durfee
Under
Willard
Cook
Perry
Basin
Evans
Spring
Grizzly
Peak
Black
Mountain
Ben
Lomond
Peak
Willard
Peak
Cutler
Spring

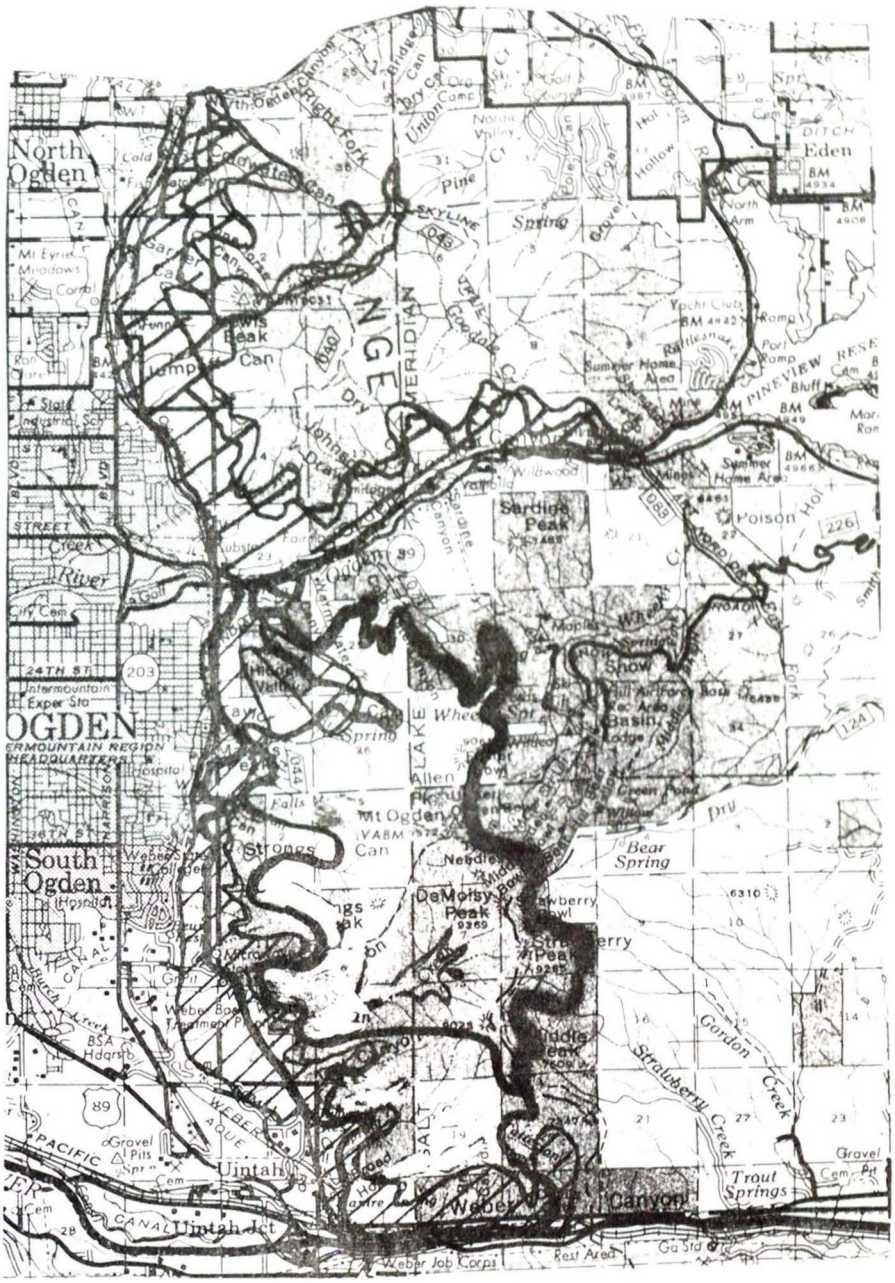
LEWIS PEAK

AND

MOUNT OGDEN UNITS

BIGHORN SHEEP
SUMMER RANGE - blue
WINTER RANGE - red

DEER WINTER RANGE - ▨


North Ogden
Eden
Lewis Peak Can
Sardine Peak
Poison Hol
OGDEN
Mt Ogden
Bear Spring
South Ogden
DeMoisy Peak
Strawberry Creek
Gordon Creek
Uintah
Uintah Jct
Weber Canyon
Trout Springs
Weber Job Corps
Rest Area
Gravel Pits
Basin
Summer Home Area
PINEVIEW RESE
Wildwood
Show
Strongs
Falls
Allen
Spring
Dry
Pine
Cold Water Can
Right Fork
Union Canyon
Johnson Canyon
Mt Eyrie Meadows
Intermountain Exper Sta
24TH ST
STREET
Creek
River
Hospital
BSA Hdqrs
PACIFIC
CANAL
WEBER
AQUE
Gravel Pits
Cem
Pit
Rest Area
Ga Std
Yacht Club
Ramp
Marina
Bluff
Fork
Smith
Green Road
Mt Ogden
Needle
Strawberry Bowl
Peak
Ridge
Hollow
Spr
Ditch
Arm
Hdqrs
Trailmen Park
Weber Basin Treatment Plant
Hospital
Intermountain Region Headquarters
Exper Sta
Gravel Pits
Pit
Cem

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